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SOME ASPECTS OF THE EFFECT OF HEAT UPON FLOUR

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(Read at the Convention June 8, 1928)

Since the publication of the writer's earlier work on the effect of heat upon wheat and flour (1926, 1927), considerable attention has been paid to this subject. This is due to the fact that the work opened up a new and promising field of research both to the pure scientist and to the more commercially minded inventor. There has, however, been little work published, probably partly for commercial reasons; nevertheless a comprehensive survey has been made recently by Berliner and Rüter (1928). In this general paper it is convenient to discuss the matter of heat treatment broadly and to make some reply to Berliner and Rüter, as this is obviously called for. This will also give the opportunity to discuss many matters of interest and to view them from a standpoint perhaps not always considered in America. Berliner and Rüter summarized the original work and announcements fairly, stating:

> The Kent-Jones' process depends upon this, that through suitable heating of wheat or wheat-flour in closed vessels and with a moderate natural moisture-content alterations take place, which are recognizable in a better working and stability of the dough and better volume of the loaves, (especially in processes involving long fermentation and with loaves which are not baked in tins). With still stronger warming the gluten becomes incapable of being washed out and the baking properties of the flour are destroyed, yet such flour, prepared under certain conditions of heating and added to ordinary flour in the proportion of 0.7% is said to bring about a marked improvement in baking quality, comparable to the effect of chemical improvers.
>
> The important researches of Kent-Jones may be summarized in the following conclusions: In the case of heat-treated flours the gluten becomes tougher and firmer, the viscosity of flour-suspensions rather higher, the solubility of the proteins in water and salts and the enzymic activity are slightly decreased. In overtreated flour the gluten is no longer capable of being washed out, the diastatic and proteolytic power is very markedly diminished, indeed almost destroyed. Changes in the starch are not capable of observation,

the solubility of albumen in water and 5% potassium sulphate solution has markedly decreased.

Kent-Jones lays great importance on the measurement of the viscosity of flour-water suspensions prepared from overtreated flour. According to him the viscosity increases enormously, while that of untreated or lightly-heated flour falls.

Kent-Jones maintains in his different publications that the addition of about 0.7% of the "K-J Flour" to baking flours shows itself less in an increase in size of loaf or improvement of texture than in dough qualities, which the practical baker most highly values. According to him the addition of "K-J Flour" makes the dough more elastic, better in its working but above everything more stable. Doughs which are inclined to flow are said to lose this property by the addition of "K-J Flour," to be capable of withstanding longer fermentation and to yield cottage loaves which stand up well.

Berliner and Rüter attempted to repeat many of the writer's investigations and on general lines confirmed that work. The criticisms they raise, however, may be considered under two headings: (1) failure to obtain as much baking benefit as the originator; (2) criticism as to the changes taking place which cause the phenomena observed.

The baking tests were not completely negative, but there is no doubt that on the whole Berliner and Rüter failed to obtain the improvement expected. These investigators themselves realize the difficulty of adequate and reliable test baking and do not appear to be completely convinced of the results they obtain. This raises the important matter of test baking. The writer's views on this are fairly well known and are perhaps not exactly orthodox, but they are based on some years of experience in the application of test baking as a reliable guide in commercial practice. This experience has indicated that the making of tin loaves should be discontinued and measurements of loaf volume dispensed with. This may appear to many in America as a heresy, but loaf volume is not, in the writer's opinion, a reliable guide for strength, especially with tin loaves, as so many factors, more or less under the control of the baker, enter into the matter; loaf volume is not determined simply by the strength of the flour, and this is particularly so when chemist-bakers are employed.

By "strength" the writer means the power of a dough to retain the gas produced within it. Even with a batch of bread entirely from one dough, made and moulded by the same baker, there will be quite marked variations in size, while one baker is always likely to get a different loaf from another with the same flour, although the fermentation and baking procedures are apparently similar. These

matters have been discussed at some length by the writer in Chapter VI of the new edition of "Modern Cereal Chemistry" and summarized thus:

> Strength may be regarded as the factor which will normally produce large well-piled loaves, provided that the gas production is sufficient, and in practice this can often best be judged from the behaviour and the properties of the fermented dough. It will be seen later that this means a sufficiency of protein, the degree of dispersion of which lies between two useful colloidal limits.

At present there seems to be a tendency among many cereal chemists to give undue prominence to oven spring. This appears to be considered the main object, and any flour improver producing oven spring, put on the market and sold to millers (not bakers), can thus obtain some popularity. This is certainly the case in England and probably also in America. What is wanted in these matters is the practical and commercial baker's viewpoint, which is far from being simply size of loaf. The baker requires a dough that works well and that can be handled easily. Within certain limits, one with which liberties can be taken.

The writer and those associated with him can claim a wide and varied experience of such matters. The improving value of persulphate was discovered by Mr. Jago, who is well known in America, and Mr. Chitty, a miller of experience and repute in England. The firm of Woodlands Ltd. was formed to exploit the persulphate patents. Today this substance is used extensively all the world over. In no country is its value more appreciated than in Germany and yet repeated trials and baking tests lasting over many years were reported to be failures. Some of the biggest German users today absolutely failed to find any benefit. The experience of Messrs. Jago and Chitty and their expert staff was different and has now been completely vindicated. It is perhaps natural, therefore, that one is not so perturbed as one might be on the face of things with indifferent laboratory baking reports. The test is the baking trade—the test of commercial practice. The heat treatment of wheat and flour can be carried out in various ways, but at present one of the simplest ways is by the addition of the strongly overheated flour at the rate of 0.7 per cent. It is interesting to note, therefore, that although this form of treatment has been on the market just under a year, enough is at present being made and sold to treat 1,500,000 sacks or 2,100,000 barrels of flour per annum. In view of the fact that so many excellent chemical improvers are on the market and that it is in its early days, this may be considered

as an appreciation by the users, who are largely millers with close connection with the baking trade. Much of this overheated flour is being used in Scotland, where it is particularly suitable for the long and severe Scotch baking process. In this connection it is of interest to recall the opinion of Meikle (1927), who carried out on a commercial scale a thorough investigation of the suitability of overheated flour for the Scotch system. He states:

> The sponge (or second stage) had a more silky feel compared with the check test and was what Scottish bakers call a very 'nice looking' sponge, standing about five minutes or so more than the usual sponge showing that "K-J" strengthens the flour even in a thin sponge. The dough (third stage) had a remarkably pleasant feel when it had been made for an hour and this improvement kept right on till the pieces were finally moulded. "K-J" whatever else it is, is absolutely a dough improver, the dough stands up well with extra water and I think from what I saw that it can be worked with softer than normal doughs with success. The extra water used in "K-J" blend was *never under* one quart per sack of 280 lbs. for the *same tightness* of dough but more water I think should be used if "K-J" is used at the rate of 2 lbs. per sack, as the dough is stabilized quite definitely.

The writer would like to emphasize his opinion that all baking tests, even on a small laboratory scale, should be carried out by an experienced commercial baker who has had some training and experience of test baking as well. By his knowledge gained in the commercial bakehouse, such a man is able to interpret the results of a small test approximately to those that would be obtained on a large scale dough. No test baker is worthy of the name unless he is able to reproduce commercially the result of his small test baking. This is naturally beyond the chemist or the more or less untrained baker who has had his original instruction in the test bakery or laboratory, which is, in the writer's opinion, the wrong end to start.

Leaving the fascinating subject of test baking, there is next to be considered the actual changes which occur during the strong heating of wheat and flour. Here again Berliner and Rüter often find themselves in disagreement with the writer. This is perhaps only to be expected, as the whole matter is one of some magnitude and is far from being worked out completely. In view of Berliner and Rüter's able criticism, the writer and his assistants propose to carry out a further investigation on this matter shortly. For instance, Berliner and Rüter apparently obtained in their experiments considerably more alteration in hydrogen-ion concentration than did the writer. There is general agreement that the effect is caused by some coagulation, or, if the term be preferred, some increased degree of aggregation, of the proteins, and the writer can confirm

that this is largely dependent on the moisture content of the substance under treatment. In the early days of the large scale experiments this was quite markedly emphasized.

Without further experiments it is not possible to deal with some of the other points raised, particularly the action of phosphatase in these heated flours. To what extent the phenomena reported by Berliner and Rüter are due to the general reduction in solubility by coagulation, it is difficult to say at present. Preliminary work would, however, seem to question what appeared to be a particularly interesting statement of the German investigators. They stated that:

> The behaviour of the "K-J Flour" is especially extraordinary in ultra-violet light, when it shines up light-blue between other untreated or only lightly heat-treated flours and differentiates itself from them in an extraordinary manner.

The overheated flour is a very granular material, and when other granular but unheated materials, such as semolina and middlings, were examined in ultra-violet light, a similar effect was observed. The effect appears to be due, mainly at any rate, to the degree of granularity and not specifically to the effects of heat.

The writer finds himself in complete disagreement with Berliner and Rüter in their final consideration, where they discuss ripening, harvesting, action of Indian wheats, etc. The writer has advanced the view that the heat treatment is not unlike the harvesting and ripening process that wheat normally undergoes. Mohs (1922) has also put forward similar considerations. He has suggested that the drying at low temperatures of poor native German wheats, so that they are brought nearer to the irreversible point than they usually are, may materially improve them. The conceptions of Mohs and the writer, although having something in common, have also points of sharp disagreement. Mohs has emphasized that to improve wheats they should be heated so as to be brought nearer to the irreversible coagulation point, and that drying and low temperature are necessary factors for this accomplishment. On the other hand the writer advocates comparatively high temperatures and long times and the performance of the operation on materials as dry as conveniently possible and without evaporation. According to the writer's theory such wheats as Indian and Persian are mainly unsatisfactory, as their proteins have already been coagulated rather too far by the natural heat of the sun. In this respect, therefore, they may be regarded as too strong. Berliner and Rüter cannot reconcile themselves to this

view and state that if this were so long fermentation would be helpful. They also say, with reference to flour milled from Indian and Persian wheats which they call "natural K-J" flour:

> If according to Kent-Jones' statements the heat coagulation of the gluten has advanced too far, a small addition of such (natural "K-J flour") would strengthen weak doughs in the same way that the "K-J flour," produced by artificial heating performs the operation.

Possibly millers and chemists of other countries have less to do with Indian and Persian wheats than English millers and chemists, as otherwise it is difficult to understand why the above statement should be made. It is true that Indian can be used to a certain degree as an overheated flour and millers often rely on its stability to help mixtures. Naturally, considerably more Indian must be used than the specially prepared overheated flour with the result that certain disadvantages are encountered, such as the reduction of the protein content of the blend and the introduction of a general harshness. When Indian is plentiful, the sale of chemical improvers falls, as naturally they are then of less value. Indian itself can be helped only by a definitely weakening agent such as malt extract. English millers have known for years that Russian and Indian make an excellent mixture, producing flour far superior in baking quality to either Russian or Indian alone. By many this was regarded as a kind of mystery and the blending was thought in some way to have added strength. The broad characteristic of Russian is high protein content, but the gluten is of a runny character. Indian has unfortunately a low protein content but the gluten is toughened until it is overstrong and becomes "short." The mixture, therefore, has a fairly satisfactory protein content and the quality is nice for baking, as the natural overheated flour has corrected the undesirable tendencies of the Russian. Even Indian and weak native English with its flowy gluten blend well, but in this case the protein content is too low for real satisfaction.

It is perhaps significant that with a flour such as that made by Russian wheat it is possible by heating to produce in it the essential characteristics of Manitoba and then, on further treatment, of Indian.

The writer (1927a) has already given a paper to the Association of British and Irish Millers, at their request, dealing with the subject of heat treatment generally, and it is unnecessary to repeat here what was then stated. The treatment may be given in many ways and a method of systematically heating the flour from the

bottom of the mill gives results which are truly astonishing. Barring colour, such flours, usually so poor, can be made into satisfactory baking ones. Where there is any restriction as to the use of chemicals such methods are obviously of immense value. After heat treatment a dough that in the untreated state tends to be too slack and sticky, and to flow out, stands up boldly, is drier, and is easier to handle. Normally there is extra water absorption and with the long Scottish sponge fermentation system as much as from 6 to 9 per cent additional water can be used. As regards loaf size, a big improvement is seen with types (such as the English cottage) in which stability is an important factor. Even with tin loaves there is usually an improvement in size and always in texture besides being more nearly "fool-proof," that is, greater liberties can be taken with dough made from flour so treated. In particular, it gives a dry feeling during the working and handling of the dough, and, in general, exhibits those characteristics which the baker likes.

Besides the commercial application of the writer's discoveries there obviously remains a tantalizing field of research which should yield rich results. It is hoped that data will gradually be collected from all over the world, that the chaff will be sifted from the grain, and that this will lead to a fuller and better knowledge of wheats and of the best ways of utilizing them for the benefit of mankind.

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EFFECT OF DRY SKIMMILK ON BAKING QUALITY OF VARIOUS FLOURS

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Milk may well be regarded as the most perfect single article of the diet. White bread, for which the American public has shown a decided preference, when fed to animals over an extended period of time has been found inadequate to supply their nutritive needs.

Sherman, Rouse, Allen, and Woods (1921) found that when rats were on a diet of white bread alone there was an immediate cessation of growth, followed by death after six weeks. In view of our present knowledge of nutrition this does not mean that white bread is not a good food. It means that white bread lacks certain essential constituents which must be supplied by other foods. There is no better single food than milk to supply these deficiencies. The use of milk in bread seems, therefore, to furnish the best method of insuring an adequate nutritive diet for the masses.

Whole milk varies in composition according to the breed of cow, period of lactation, character of feed, and thoroness of milking. The average composition of cow's milk is:

Water	87.27	per cent
Casein	2.95	" "
Albumin	0.52	" "
Sugar	4.91	" "
Fat	3.66	" "
Ash	0.69	" "

Among the most important of the constituents of milk that enhance the nutritive value of bread are its mineral salt, lactose, and proteins.

Mineral Salt.—American dietaries are more likely to be deficient in calcium than in any other element. Whole milk contains about 0.119 per cent of calcium and white flour contains but 0.013 per cent. Milk, therefore, has about nine times as much of this relatively uncommon but highly essential element as flour. Furthermore, the calcium in milk is in a form which is readily utilized by the body.

Lactose.—Because lactose is the only sugar in milk, we assume that it possesses characteristics that make it valuable in

nutrition. It is generally prescribed by physicians for modifying cow's milk for infant feeding. It has therapeutic value because of its effect on the bacterial flora of the large intestine. The galactosides, phrenosin, and kerasin are found in the medullary sheaths of the white matter of the brain.

Protein.—The work of Kossel has shown that quality of protein as well as quantity must be considered. Abderhalden and others assume that the animal must construct its tissue from the amino acid fragments furnished by hydrolysis. It is obvious that deficiencies in one or more of these amino acids lead to serious nutritive disturbances. The nutritive value of a protein is measured by the products that it contributes toward maintenance and growth. The nutritive value of many of the common proteins has been determined. Osborne and Mendel (1912, 1913) assign a higher nutritive value to milk proteins than to cereal proteins. Similar conclusions were arrived at by McCollum and Davis (1915), Rose and MacLeod (1925), and others.

Sherman, Rouse, Allen, and Woods (1921), in studying the effects of feeding experiments upon growing animals, used white bread made with water and with varying quantities of milk. These investigators obtained marked improvement as a result of replacing half the water used in bread making by milk. These findings were confirmed by Morison and Amidon (1923).

Evaporated, sweetened condensed, and dried milks are the forms most frequently used by the baker. Evaporated milk is cow's milk evaporated to half its original volume. All the constituents of the whole milk are in their original proportions except the water. Condensed milk is made by adding 15 per cent of cane sugar to the milk and then removing a large part of the water by evaporation. It is condensed to about two-thirds its orginal volume. Dried milk is made by removing nearly all the water. Sherman, Rouse, Allen, and Woods (1921) have demonstrated by experiments upon rats that when whole milk is replaced by dried milk, or when the whole milk is used in bread making and therefore subjected to the heat involved in baking bread, there is no appreciable effect on the growth-promoting property of the milk.

Bread and milk taken together are as nearly balanced as two foods can be. If all bread were milk bread, our people would be better nourished. It is very fortunate that milk solids supply the important nutrient substances which the non-milk loaf lacks, and for this reason the use of milk in bread is very highly recommended.

In addition to its nutritive effects, milk improves the properties of the bread and enhances the ease of manufacture. Amidon (1926) reports an increase in the stability of dough containing 5 per cent of dried skimmilk as compared with bread containing no milk. As a result of incorporating dried skimmilk in the dough batch, Amidon (1926) found an improvement in absorption, loaf volume, color of crust, character of crust, color of crumb, break, shred, flavor, taste, and texture of the bread.

At times bakers have reported unsatisfactory results when milk was used in bread making. Flours differ in protein content, diastatic activity, bleach, and other properties that influence the ease of bread manufacture and for this reason a study was made of the reaction of different flours to the use of milk in the dough.

Experimental

Source and description of flour samples.—The description of these flour samples, as given by the millers, is as follows:

No. 1. A 95 per cent patent milled from hard winter wheat.

No. 2. A 95 per cent patent milled on a 4.30 yield from a dark hard Kansas wheat.

No. 3. A medium short patent.

No. 4. A 95 per cent patent flour milled from all hard spring wheat.

No. 5. A 95 per cent patent made on a 4.29 yield from a mixture of 100 per cent spring wheat.

No. 6. A 95 per cent patent flour milled from red winter wheat grown in Ohio.

No. 7. A 95 per cent patent flour milled from a mixture of soft winter wheats grown in Ohio and New York.

The flours were milled from wheat grown in 1926. The mills from which samples Nos. 4 and 5 were obtained were selected because their location is such that it is to be expected that only hard spring wheat will be used in the wheat mixture. The composition of the flours is reported in Table I.

TABLE I
COMPOSITION OF THE FLOURS (DRY BASIS)

Lab. No.	Ash	Protein
	per cent	per cent
1	0.475	14.19
2	.509	13.64
3	.520	14.81
4	.468	13.04
5	.463	14.46
6	.530	10.11
7	0.472	9.71

Baking tests of the flours.—It is the experience of every baker that different flours will show different properties when baked into bread. Baking properties are affected by variety of wheat, climatic and soil conditions under which the wheat is grown, tempering and other milling conditions, grade of flour, bleach, and other factors. The so-called "flour improvers" are frequently added to the dough batch in the bakery. Different flours will react in a different manner to these reagents. It is to be expected that when milk is used in bread making there will be a variation in the effects produced with different flours. Two hard winter wheat flours, two hard spring wheat flours, two soft winter wheat flours, and one hard wheat flour of unknown history were selected for a study of the variation that may be encountered in different flours when milk is used in making bread. Six flours were 95 per cent patents, selected because this grade is frequently used by the baker.

Preliminary experiments indicate that all dried skimmilk does not produce the same effects when used in bread making. Different samples showed variation in their effects upon absorption, fermentation tolerance, proof period, volume, break, shred, crust color, grain, crumb color, and texture. In general, however, the addition of dried skimmilk resulted in an improvement in the loaf, some samples resulting in greater improvement than others. There is a slight variation in the chemical composition of dried skimmilk. The average composition is as follows:

Water	3.89	per cent
Protein	35.42	"
Butterfat	1.74	"
Lactose	48.74	"
Ash	8.08	"

The dry skimmilk used in this investigation was one which in previous work had given favorable results when used with hard spring wheat flours.

The formula used in bread making was the one under investigation by the Committee on Standardization of the Experimental Baking Test, of the American Association of Cereal Chemists. The formula follows:

Flour	100.0	grams
Compressed yeast	3.0	"
Sugar	2.5	"
Salt	2.0	"
Water	Sufficient	

The method of procedure being studied by this committee was used, but was modified according to the phase of the

work under consideration. This procedure is as follows: Mix the doughs. Ferment the doughs 180 minutes at 30° C. with 105 minutes to the first punch, and the second punch 50 minutes later. Proof the dough 55 minutes at 30° C. Bake the bread 25 minutes at 230° C. The baked loaves of bread were scored for volume, crust color, break and shred, crumb color, and grain. At the present time volume is the only factor in which exact physical quantitative measurements may be taken. Measurements of other factors will vary according to the individual who judges the bread.

Four series of experiments were performed on each flour. The first consisted in a comparative study of the seven samples of flour. Effect of time of fermentation period, time of proof period, and temperature of proof periods were the variants in the other three series.

Series I. A comparative study of the seven flours.— In this series the bread was made according to the above formula and procedure. Milk was not used. The results obtained are recorded in Table II. Flour No. 1 was used as a standard and given a score of 100. Flours Nos. 6 and 7, tho soft wheat flours, were judged on the same scale as the hard wheat flours.

TABLE II

RESULTS OF BAKING TEST OF FLOUR SAMPLES

Following the formula and method of procedure under investigation by the Committee on Standardization of the Experimental Baking Tests, of the American Association of Cereal Chemists.

Lab. No.	Absorption	Loaf volume	Crust color score	Break and shred score	Grain score	Crumb color score	Texture score
	per cent	cc.					
1	61	400	100	100	100	100	100
2	63	385	101	101	96	97	98
3	65	410	103	97	96	98	101
4	60	410	100	101	98	98	101
5	61	355	97	93	94	87	100
6	55	380	80	83	88	97	85
7	52	360	75	88	86	95	70

Series II. Effect of time of fermentation period.—There were two groups to this series, one in which 4 per cent dried skimmilk was used and one in which milk was not used. The doughs were given fermentation periods ranging from 60 to 210 minutes and taken at 10-minute intervals. Other than the addition of milk and the change in fermentation period, the method and procedure were the same as in Series I. The loaf volumes obtained are recorded in Figures 1 to 7. With flours Nos. 1, 2, 4, 5, and 6, there was an increase in volume due to the presence of milk whereas with flours Nos. 3 and 7 there was a decrease.

Flours are classified as strong and weak. Strength, stabilility, and fermentation tolerance are among the terms used to define this property. Humphries (1905) defines it as the capacity of flours to make large, well piled loaves. "The physical extensibility of dough as indicated by the manner in which it handles in the bake shop" is the definition given by Bailey (1925), which is an excellent definition of flour strength when applied to modern bakery practice.

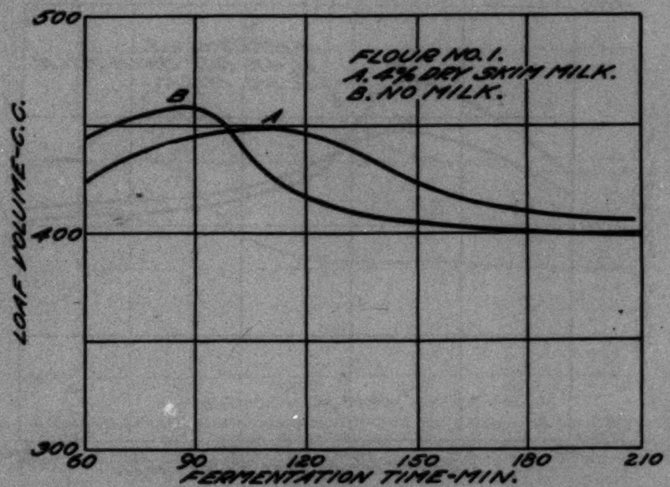

Fig. 1. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 1

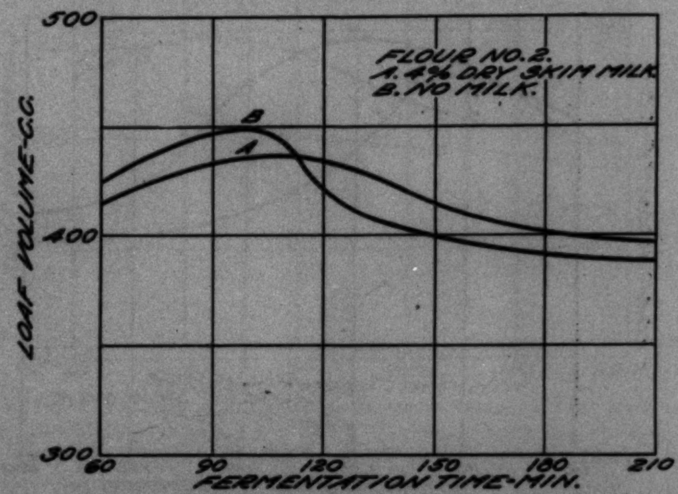

Fig. 2. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 2

Strong flours vary in this property. The stronger the flour the easier it is for the baker to produce bread of uniform quality from day to day. One of the desirable properties of strong flour as compared to weak flour is its ability to give good bread over a wider range of fermentation time. This period may be greatly prolonged by the use of dried skimmilk, as may be seen in Figures 1 to 7. Dried skimmilk increases the capacity of flour to make large, well piled loaves and it increases the physical extensibility

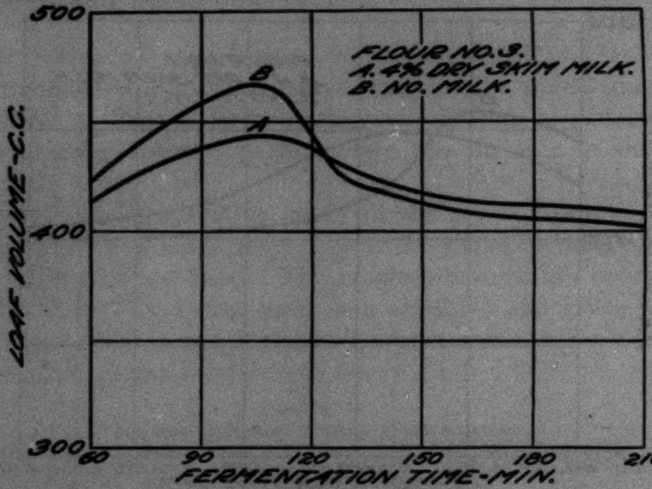

Fig. 3. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 3

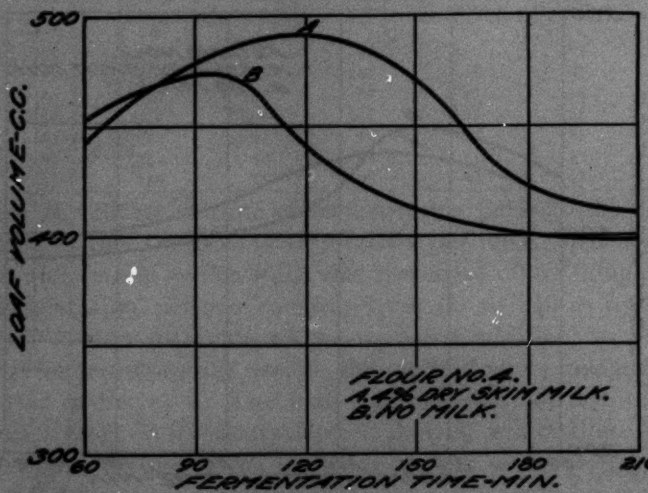

Fig. 4. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 4

of dough, as indicated by the manner in which it is handled in the bake shop, and as such is a very important addition to bread. Bakers pay higher prices for strong bread flours than for those that have this property to a less degree. This property for which bakers are willing to pay an extra price may be imparted to doughs by the use of milk.

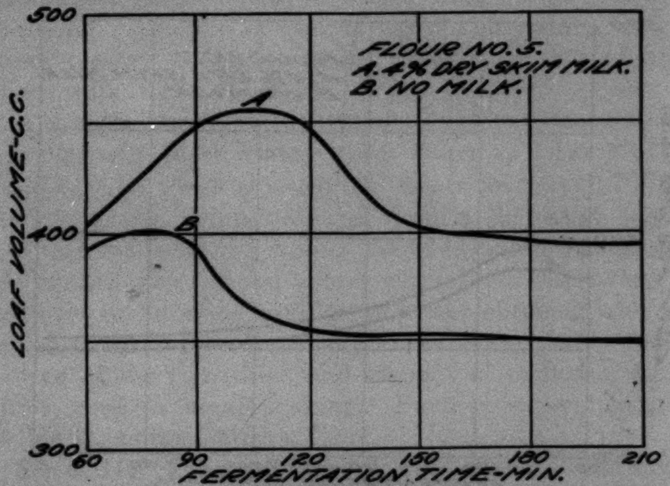

Fig. 5. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 5

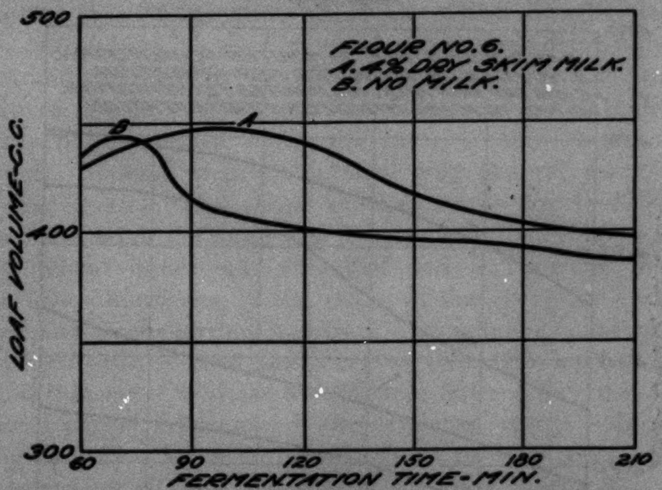

Fig. 6. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 6

In the seven samples with which milk was used, crust color was improved as a result of the unfermentable lactose in the milk. In these seven samples, both with and without milk, there was a

decrease in intensity of the crust color as the length of the fermentation period increased. On the young side of the proper fermentation period all flours gave a poorer grain in the milk bread than in the bread without milk. With both milk bread and bread without milk the grain became finer with length of fermentation period. At proper fermentation periods and even beyond these

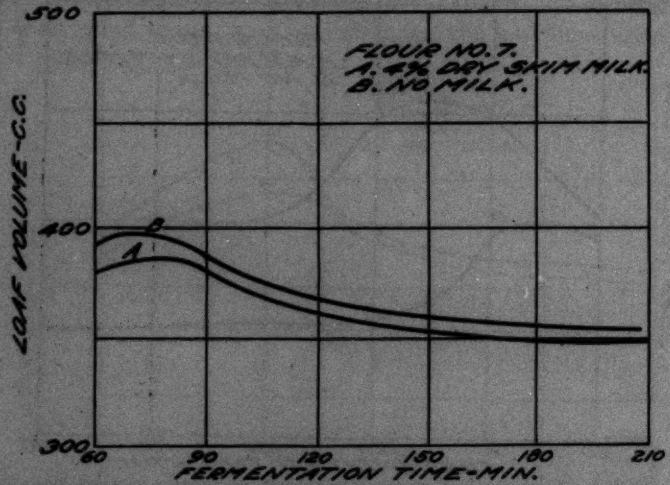

Fig. 7. Effect of Length of Fermentation Period on Volume of Loaf Made from Flour No. 7

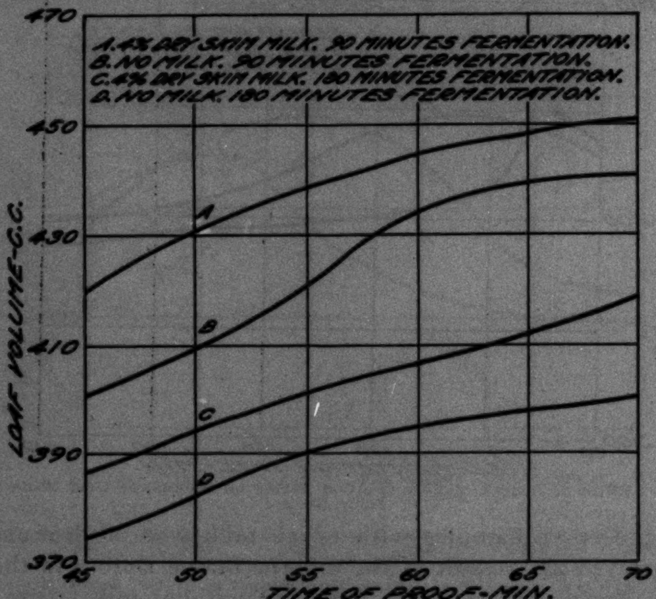

Fig. 8. Effect of Length of Proof Period on Average Loaf Volume of Hard Wheat Flour

periods flours Nos. 1, 2, 4, 5, and 6 gave better grain with the use of milk than without the use of milk. This was not the case, however, with the bread made from flours Nos. 3 and 7. In all flours except Nos. 3 and 7 there was an improvement in break and shred when milk was used. In both milk bread and bread made without milk the size of the break increased with the length of fermentation period. Addition of milk to the dough resulted in bread with a more creamy and more glossy color than that of bread made without milk.

A greater improvement was obtained with hard spring wheat flours than with hard winter wheat flours as a result of the use of milk in bread. It will be noted that flours Nos. 3 and 7 did not react favorably to the incorporation of milk in the dough batch. Flour No. 3 was made from a strong hard red winter wheat, No. 7 was made from a very soft red winter wheat. An improvement in milk bread over bread made without milk was obtained with both these samples when certain flour improvers were used. This suggests the need of the right kind and amount of oxidizing agents when milk is used in bread making. Further experimentation along this line is contemplated.

Series III. Effect of time of proof period.—The doughs used in this series were fermented for the two periods—90 and 180 minutes at a temperature of 30°C. These doughs were divided into two sub-series, one in which 4 per cent dried skimmilk was used and the other in which no milk was used. The proof periods were 45, 50, 55, 60, 65, and 70 minutes. In general, the five hard wheat flours reacted much the same to this variation in proof period. Because of this similarity only general results are given in the report. The shape of the curves for loaf volume was much the same for these five flours. The loaf volume for the five hard wheat flours was averaged and is recorded in Figure 8. There is a similarity in the shape of the curve for each group at these two fermentation periods. The volume curve of the bread in which milk is used continues to rise with increase in time of proof, that made without milk almost flattens out over the last 15-minute period. Because of the tendency of the soft wheat flour dough to break open with an increase in proof time, the loaf volumes are not of value and are not shown in Figure 8.

In judging the baked bread in this series the grain was found to be the most significant factor. When made with milk and fermented 180 minutes, flour No. 3 gave the best grain structure with a 60-minute proof period. Flours Nos. 1, 2, 4, and 5 gave the best

grain with a 55-minute proof period; flours Nos. 6 and 7 gave the best grain structure when proofed 50 minutes. Doughs fermented 90 minutes gave the best grain structure in a slightly shorter proof period than those fermented 180 minutes. The doughs in which milk was used had the best grain structure in a proof period about five minutes shorter than that of the bread made from the same flour and without milk. In the proof periods ranging from 45 to 65 minutes, a greater variation in grain was found when milk was used in the dough than when it was not used, as is shown in Figures 9 and 10. Flour No. 4 was used for bread from which these figures were made. Overproofing of milk bread results in a coarse-grained undesirable product and is a more serious factor than in bread made without milk. The fact that milk bread when overproofed continues to increase in volume to a greater extent than bread made without milk probably accounts for this coarse grain.

Break decreases in size with length of proof period. Loaves undergoing the longer proof periods have a more bulging appearance.

Series IV. Effect of temperature on proof period.—In this series an investigation was undertaken to determine whether or not it is desirable to use different proof temperatures with different flours when milk is used in the dough mixture. The first sub-series consisted in doughs fermented at 27°C., and proof temperatures of 27° and 30°C. were compared. In the second sub-series the doughs were fermented at 30°C. and proofed at 30° and 35°C. Four per cent dried skimmilk was added to all the doughs used in this series. Preliminary work indicated that for a rise of one degree Centigrade a decrease of approximately one minute in time of proof period gives corresponding results when judged on the baked loaf of bread. Proof temperatures were studied on doughs fermented for 60 minutes, which is less than the optimum fermentation period; 100 minutes, which is nearly the optimum period; and 180 minutes, which is beyond the optimum period. In Series III it was observed that grain structure was the best test in judging underproofed and overproofed doughs, as there is a decided increase in openness in grain structure with increase in proof time. In Series IV three proof periods were used in order that a more careful study of effect of temperature might be made, as in fermentation processes time and temperature bear a very close relationship. The proof periods selected were those near the optimum.

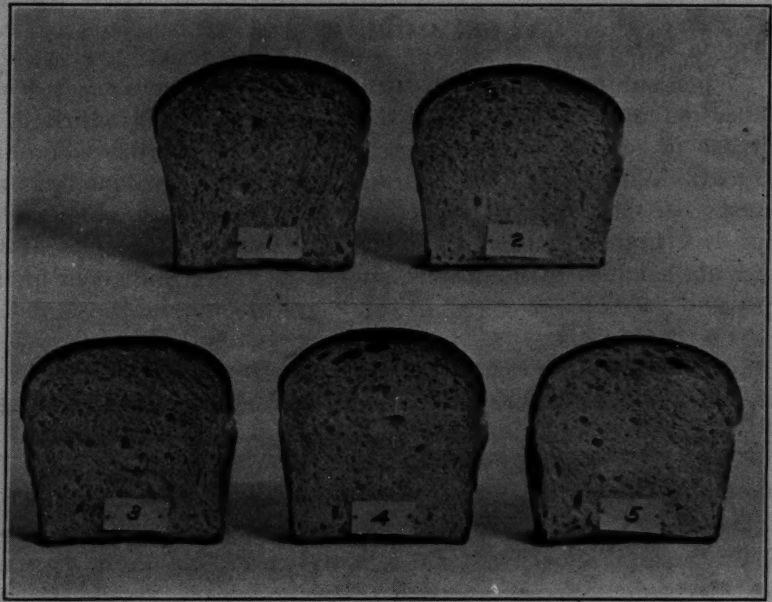

Fig. 9. Effect of Varying Proof Period when 4 per Cent of Dry Skimmilk is Added to the Basic Formula

No. 1 proofed 65 minutes No. 2 proofed 60 minutes
No. 3 proofed 55 minutes No. 4 proofed 50 minutes No. 5 proofed 45 minutes

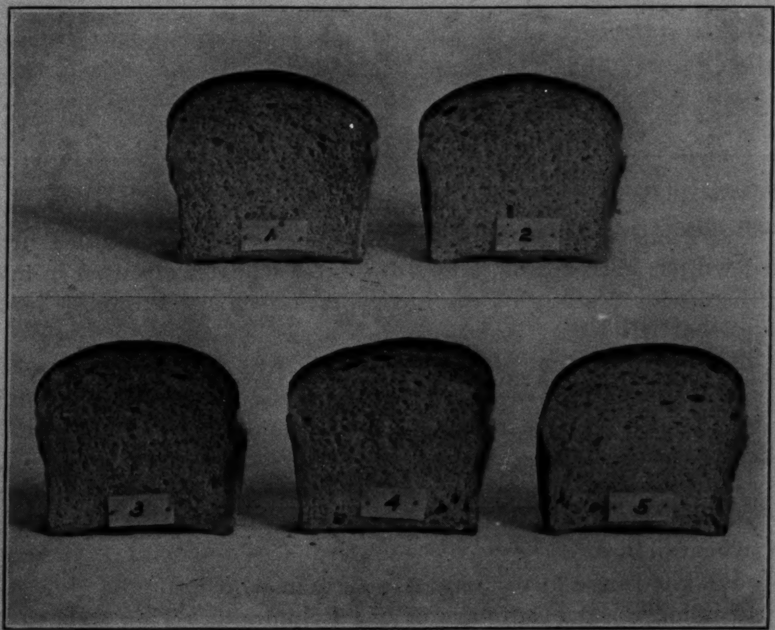

Fig. 10. Effect of Varying Proof Period when no Milk is Added to the Basic Formula

No. 1 proofed 65 minutes No. 2 proofed 60 minutes
No. 3 proofed 55 minutes No. 4 proofed 50 minutes No. 5 proofed 45 minutes

When subjected to this treatment all seven flours reacted in a similar manner. When period of proof was properly adjusted, an increase in temperature produced little change in the volume of the loaf. With two of the flours slightly greater volume was obtained with the higher temperatures. The results obtained on flour No. 1 are recorded in Table III. Since the results of the other six samples of flour were similar they are not given in this report.

TABLE III
EFFECT ON THE BAKING RESULTS OF VARYING PROOF TEMPERATURE
Flour No. 1

Fermentation time	Proof time	Proof temp.	Volume	Grain
min.	min.	cc.	cc.	score
60	50	30	455	85
60	47	30	460	89
60	44	30	450	90
60	45	35	460	85
60	42	35	455	89
60	39	35	440	89
100	52	30	480	102
100	49	30	470	105
100	46	30	460	104
100	47	35	470	102
100	44	35	470	104
100	41	35	450	103
180	54	30	395	98
180	51	30	400	100
180	48	30	385	99
180	49	35	400	98
180	46	35	400	100
180	43	35	395	97

Summary

1. Flour samples representing 95 per cent flours milled from hard winter, hard spring, and soft winter wheat were used in making bread for a study of the incorporation of dry skimmilk in the dough batch.

2. Four per cent of dried skimmilk was used.

3. Flours differ in their reaction to the use of dried skimmilk in bread making. In some the baking qualities are improved, in others they are not.

4. The hard spring wheat flours used in this experiment reacted more favorably to the use of dried skimmilk than hard winter wheat flours.

5. The range of fermentation time in which doughs give good bread is increased by the use of dried skimmilk. This adds to the ease of bread manufacture and is a very important property.

6. Lactose, which is not fermented by yeast, imparts a beau-

tiful golden brown color to the crust of the baked loaf of bread. Forty-eight per cent of dried skimmilk is lactose.

7. Break and shred are improved by the use of dried skimmilk. The shreds are long and smooth and there is a decrease in the tendency to break.

8. The color of the crumb is more creamy and more glossy as a result of the use of dry skimmilk.

9. Proof period is affected by the use of dry skimmilk in bread. Overproofing of milk bread is more detrimental than overproofing of bread made without milk. There is a greater increase in volume as the result of overproofing a dough containing milk than in a dough which has no milk; and with this increase in volume there is an increase in the coarseness of the grain.

10. Doughs containing dry skimmilk proofed at 27° and 30°C. and at 30° and 35°C. were compared. When proper adjustments for time were made, with these changes in temperature, similar results were obtained regardless of the proof temperature used. No harmful effects were obtained by proofing at 35°C.

Acknowledgment

This investigation was conducted in the laboratories of the Bureau of Chemistry and Soils in charge of L. H. Bailey. It is with pleasure that the author takes this opportunity to express her appreciation to Mr. Bailey for helpful suggestions, and to the Bureau of Chemistry and Soils for the use of its facilities.

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SOME APPLICATIONS OF SPECTROPHOTOMETRIC METHODS TO BAKING PROBLEMS[1]

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Color, one of the significant characteristics of baked products, is in all likelihood the most difficult to measure and record. Various expressions and terms are used to describe colors, their hue, intensity, and purity, and the conception conveyed to one individual by these terms may differ greatly from that conveyed to another. In judging cookies, for example, the expression, "golden brown" is often used to describe the most desirable color. Golden brown covers a wide range and accordingly tells little about the actual properties of the light reflected from the opaque surface of a cookie. It gives no definite measure of the brilliance of the color or the proportion of the total amount of standard white light falling upon it which is reflected by the cookie. The term gives only a very general idea of the hue, or dominant wave length, as this property is expressed in terms of the length of the dominant wave in Ångstrom units or in terms of millimicrons. Finally, the term "golden brown" lacks definiteness so far as the purity of the color is concerned, this property being that attribute of any color which determines the degree in which it possesses hue.

The need for a definite method for the physical measurement of color and its properties became evident in connection with a study of the properties of molasses in their relation to the appearance or color of cookies in which molasses was a prominent part of the formula. Several samples of molasses were used that were obviously of widely varying characteristics. Two of the samples would be characterized as high-grade, two as medium-grade, and two as low-grade products. It was necessary to attempt to trace the properties of the molasses into the finished cookies and at the same time to ascertain the effect of other ingredients and varying treatments in baking upon the appearance

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of the surface of the baked product. Early in the study it became evident that substantial variations in color resulted from these factors, and a quantitative measurement of the color properties of the molasses and of the baked cookies was necessary in order to have a satisfactory record of the direction and extent of the effect of these variables.

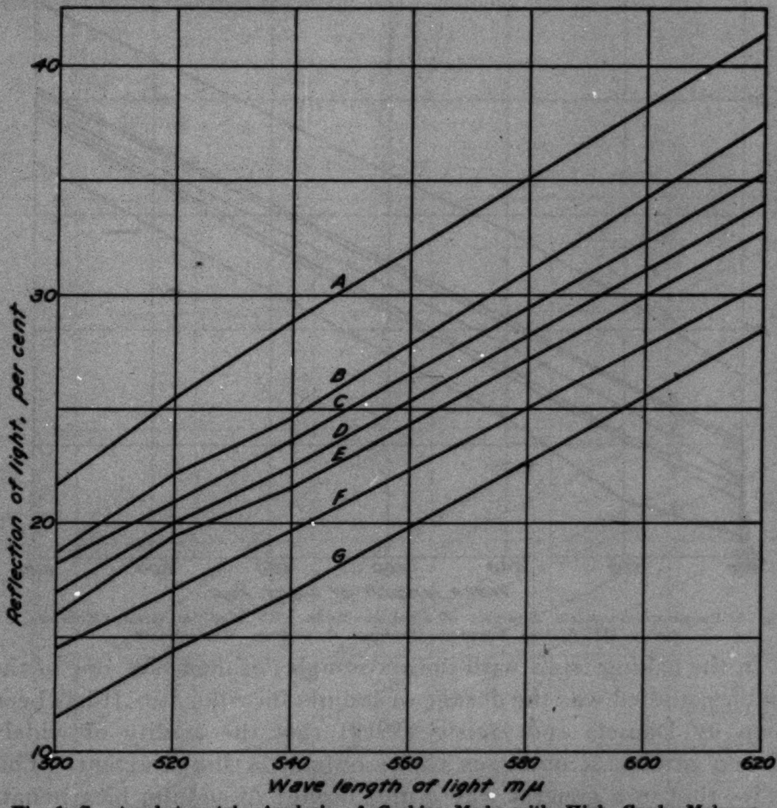

Fig. 1. Spectrophotometric Analysis of Cookies Made with High Grade Molasses, Series II, Using Varying Dosages of Sodium Bicarbonate

The spectrophotometer enables the observer to measure and record the percentage of white light directed upon an opaque surface that is reflected by that surface, observations being made at definite and predetermined positions in the visible spectrum. In brief, the instrument provides (a) a source of suitable white light, (b) a spectroscope that facilitates observations in the desired wave length, and (c) a photometer. With this instrument the percentage of light reflected is observed at several wave lengths. A

typical graphic record of such observations will be found in Figures 1 to 6, through the range from 500 to 620 mμ.

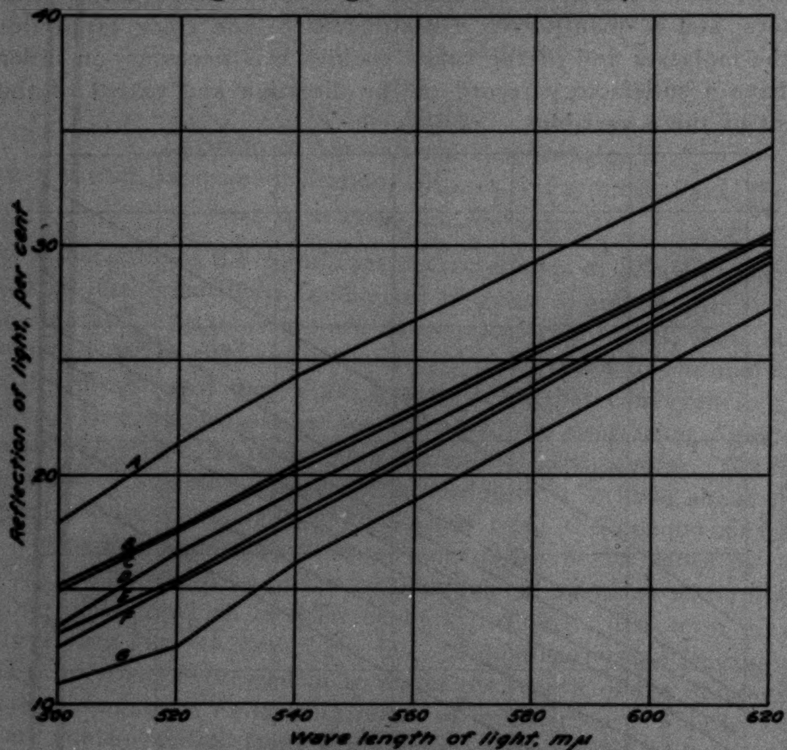

Fig. 2. Spectrophotometric Analysis of Cookies Made with Medium Grade Molasses, Series III, Using Varying Dosages of Sodium Bicarbonate

In the baking trials with the six samples of molasses, one of the variables studied was the dosage of sodium bicarbonate. It has been shown by Daniels and Heisig (1919) that the acidity of widely differing grades of molasses varies only to a slight extent. This implies that in a general way a unit dosage of sodium bicarbonate would result in a dough batch containing the same quantity of flour and molasses and having a definite H-ion concentration. Such an assumption can be made only if the buffer index of the different molasses does not vary widely. The experience in this connection indicates that both acidity and buffer value vary somewhat from sample to sample, altho the variations in H-ion concentration (as pH) of cookies made with the same quantities of sodium bicarbonate varied within relatively narrow limits, and these variations may be partly due to inadvertent differences in baking manipulation.

The visual appearance of the molasses, as well as their chemical composition and flavor, was widely different.

It then became necessary to ascertain the extent to which these variations in the molasses would register in the cookies in which they were used. To this end, baking trials were conducted, using the following formula:

Flour	220 gm.
Molasses	130 "
Sucrose	20 "
Shortening	35 "
Whole egg	36 "
Salt	2 "
Sodium bicarbonate, varied from	0–5 "

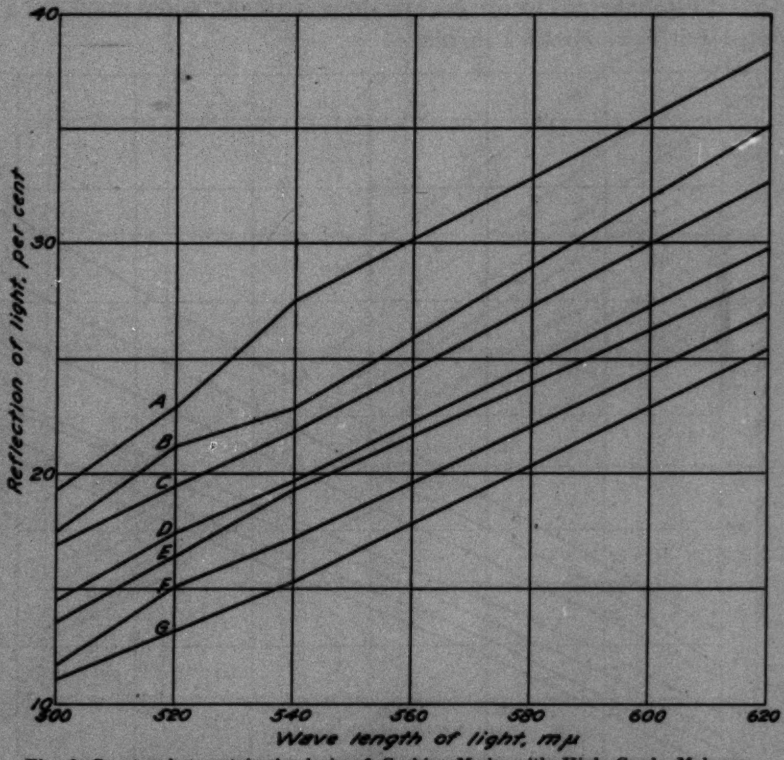

Fig. 3. Spectrophotometric Analysis of Cookies Made with High Grade Molasses, Series VII, Using Varying Dosages of Sodium Bicarbonate

The dough was compounded as follows: The shortening, sucrose, and salt were creamed. The egg was beaten with 30 revolutions of a rotary egg beater and stirred into the creamed mixture. The molasses was then added, and the whole was stirred lightly. The sodium bicarbonate was thoroly mixed by repeated sifting

with 100 grams of the flour, and this was combined with the creamed mixture. A second 100-gram portion of the flour was then stirred into this batch, stirring as little as possible to form a reasonably smooth paste, or dough. The remaining 20 grams of the flour was used on the board to prevent sticking during the rolling and cutting process, being ultimately worked into the batch. The sheet of dough was rolled, using side supports for the rolling pin that were 3 mm. thick. The cookie cutter was 54 mm. in diameter. The cut portions were transferred to four flat sheets of tinned iron, 48 cookies constituting the usual batch. These were baked in an automatically regulated gas oven for 6 minutes at 232° C. (450° F.). The tins were then removed from the oven and cooled with the cookies in place.

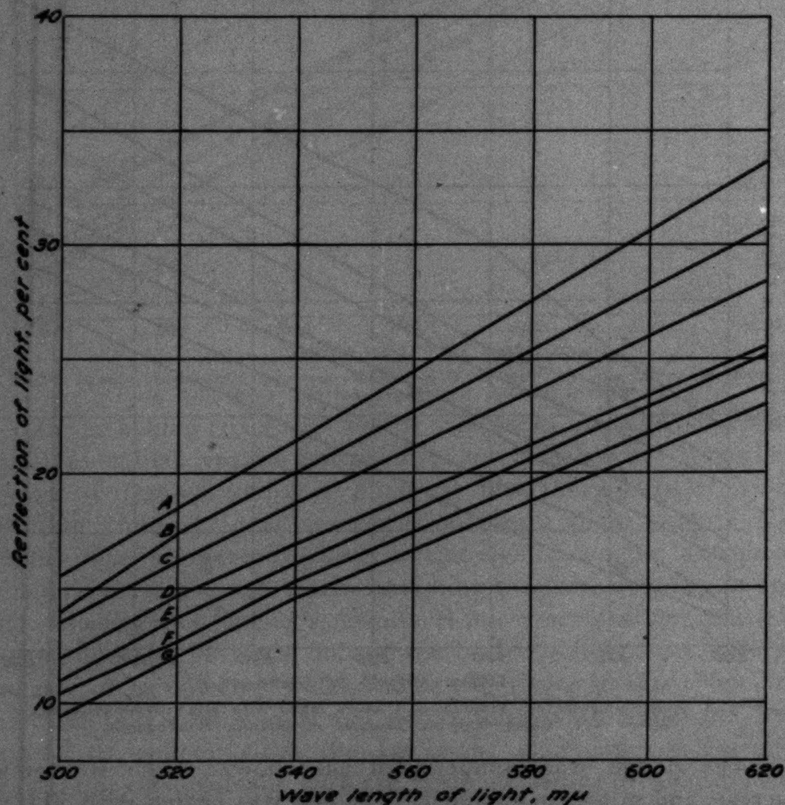

Fig. 4. Spectrophotometric Analysis of Cookies Made with Low Grade Molasses, Series IV, Using Varying Dosages of Sodium Bicarbonate

As indicated in the formula, the dosage of sodium bicarbonate was varied from 0 (control dough) to 5 grams. The actual dosages

in the seven batches made with each molasses contained accordingly 0, 0.5, 1, 2, 3, 4, and 5 grams per batch, respectively.

In addition to the color properties, discussed in this paper, texture, odor, and flavor were observed. The judges who scored these cookies agreed that the batches (designated by E) which contained 3 grams of sodium bicarbonate, were superior in flavor. The H-ion concentration of these batches varied between pH = 7.5 and pH = 8.4, with the majority falling within the range pH=7.7–8.1.

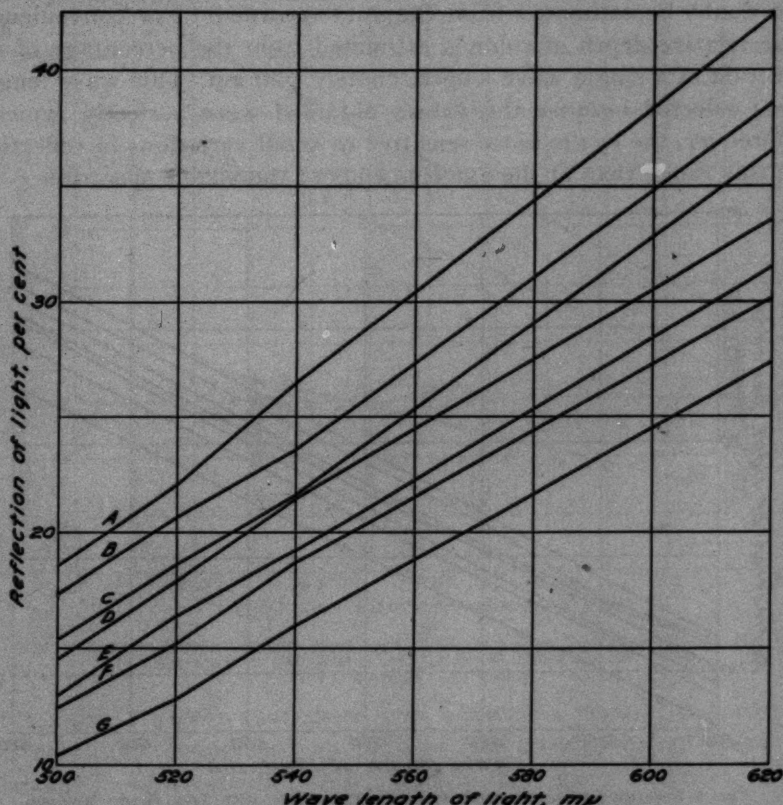

Fig. 5. Spectrophotometric Analysis of Cookies Made with Medium Grade Molasses, Series V. Using Varying Dosages of Sodium Bicardonate

Influence of Sodium Bicarbonate Dosage and H-ion Concentration on Color of Cookies

The spectrophotometric measurement of two representative cookies from each batch was then determined. These observations did not modify any of the properties of the cookie, which was

accordingly available for the determination of its H-ion concentration. In all instances recorded in Table I, the H-ion concentration (as pH) is that of the cookie which was subjected to spectrophotometric study. The complete series of observations with the spectrophotometer is recorded graphically in Figures 1 to 6. In a general way the curves are thoroly regular and approach a straight line in progressing from the percentage reflection at 500 mμ. to that at 620 mμ. For this reason, the data were not subjected to computation of brilliance, hue, and saturation, altho such values could no doubt be estimated from the data recorded. For convenience, the relative depth of color is estimated from the percentage of reflection of a single wave length, namely, 540 mμ. This wave length was selected because the values obtained were perfectly typical; moreover, the eye is more sensitive to small variations in reflection in this range than at the extreme ends of the visible spectrum.

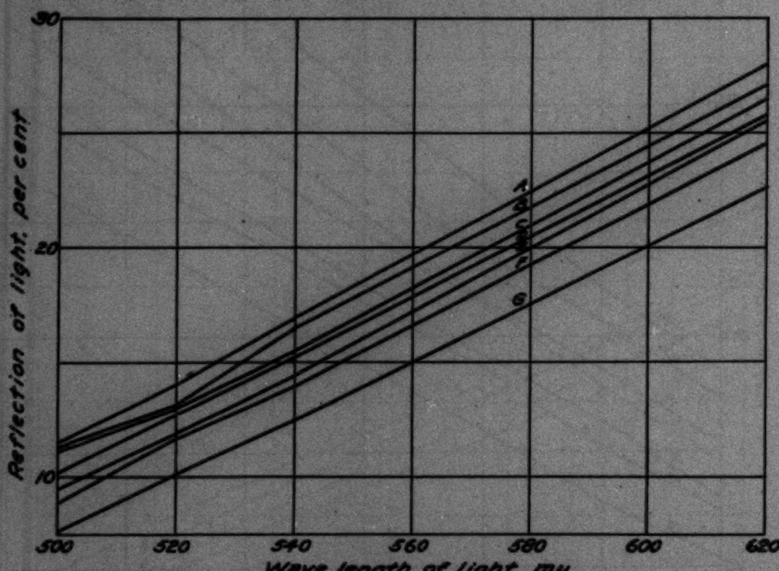

Fig. 6 Spectrophotometric Analysis of Cookies Made with Low Grade Molasses, Series VI, Using Varying Dosages of Sodium Bicarbonate

Using the data in Figure 1 as an illustration, it appears that, owing to the combination of colors represented by these golden brown cookies, there was a substantial absorption of light throughout the visible spectrum. This absorption reached its highest values in approaching the blue end of the spectrum, which means that the obvious hues were registered between the yellow and the

red. This fact is responsible for the characterization of cookie color commonly employed.

Also, there was a regular progression in the percentage of reflection with the dosage of sodium bicarbonate as the variable. The cookies baked from the batches that contained the least sodium bicarbonate were invariably lightest in color and accordingly reflected more light than those containing larger dosages.

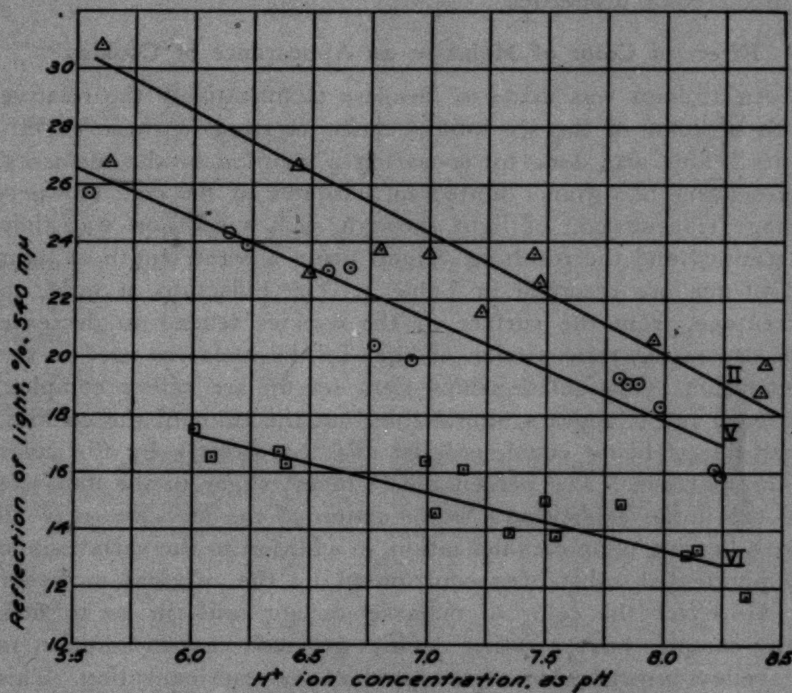

Fig. 7. Relation Between Reflection of Light (540 mμ) from Cookies, and their H+-ion Concentration as pH, with Three Grades of Molasses, (II) High, (V) Medium, (VI) Low

Table I shows that there was likewise a regular progression in alkalinity (expressed as pH) of the cookies baked from the batches in which sodium bicarbonate dosage was a variable. It has already been indicated that the judges who scored these cookies expressed a preference for those having an H-ion concentration between pH = 7.7 and 8.1. The relative regularity of change in color value with changing H-ion concentration is evident from the data expressed graphically in Figure 7. In this figure the absorption of light, having a wave length of 540 mμ is plotted as ordinates and the H-ion concentration as pH is plotted as abscissas. In the

preparation of this chart, only three series of cookie batches were included. These were prepared with high-grade (II), medium-grade (V), and low-grade (VI) molasses. The progression in terms of diminishing reflection by increasing degree of alkalinity was fairly regular in the instance of individual batches in each series; at least it was as regular as might be anticipated in view of the known effect of other variables, including time and temperature of baking, upon the color properties.

Effect of Color of Molasses on Appearance of Cookies

An attempt was made to measure quantitatively the relative depth of color of the six lots of molasses used in these experiments. This was done by preparing a solution of the molasses, representing 12.5 grams diluted to a volume of 100 cc. The percentage transmission of light through such a solution was then determined and the resulting values, using a wave length of light of 540 mμ, are recorded in Table I. The reflection of light, in percentage, from the surface of the cookies tended to decrease with decreasing transmission of light by the molasses used in the preparation. The relationships thus set up are rather complex, however, and it appears improbable that the color of the cookies, other things being equal, will be affected directly by the color of the molasses. The percentage of invert sugar in the molasses and the initial acidity and buffer action of the molasses may all have a bearing upon caramelization, in addition to the variations in the pigmented substances contributed by the original molasses.

Moreover the color of molasses is not uniform as to hue. Many samples have a rather definite greenish cast in addition to the yellow-brown color of the products of caramelization. This greenish hue is not uncommonly transmitted to the cookies.

Referring again to Figure 2, the three samples of molasses used in this series of bakes, when subjected to the determination of the transmission of light at 540 mμ, gave values of 33.3 per cent (II), 8.4 per cent (V), and 1.1 per cent (VI), respectively. The reflection of light from the resulting cookies varied directly with the color value of the molasses, as recorded in the manner already indicated. The proportional relationship in the baked cookies is not the same as in the original molasses, owing in part, no doubt, to the other properties of molasses as well as to the dilution of the molasses by the other constituents of the cookie batch.

TABLE I

COLOR OF COOKIES, IN TERMS OF REFLECTION OF LIGHT (540 mμ) AND H-ION CONCENTRATION, AS pH

	SERIES II		SERIES III		SERIES VII	
$NaHCO_3$ per batch	Reflection at 540 mμ	pH	Reflection at 540 mμ	pH	Reflection at 540 mμ	pH
gm.	per cent		per cent		per cent	
0	30.8	5.61	25.6	5.52	27.1	5.91
A 0	26.8	5.64	23.0	6.08	26.9	5.96
Average	28.8		24.3		27.5	
0.5	26.7	6.44	21.5	6.40	23.5	6.45
B 0.5	22.7	6.49	19.5	6.45	22.1	6.62
Average	24.7		20.5		22.8	
1.0	23.7	6.79	22.0	6.88	22.8	6.77
C 1.0	23.6	6.99	18.4	6.98	20.8	6.83
Average	23.6		20.2		21.8	
2.0	23.4	7.45	20.2	7.30	20.3	7.33
D 2.0	21.6	7.22	18.4	7.38	19.1	7.40
Average	22.5		19.3		19.7	
3.0	22.6	7.47	19.0	8.35	19.7	8.06
E 3.0	20.6	7.96	17.6	8.42	18.9	8.18
Average	21.6		18.3		19.3	
4.0	19.7	8.40	18.3	8.60	16.5	8.31
F 4.0	18.8	8.16	17.7	8.63	17.9	8.18
Average	19.2		18.0		17.2	
5.0	17.9	8.90	16.2	8.85	14.9	8.45
G 5.0	15.9	8.58	16.0	8.89	15.7	8.40
Average	16.9		16.1		15.3	

	SERIES IV		SERIES V		SERIES VI	
$NaHCO_3$ per batch	Reflection at 540 mμ	pH	Reflection at 540 mμ	pH	Reflection at 540 mμ	pH
gm.	per cent		per cent		per cent	
0	20.8	5.81	25.7	5.56	17.5	6.01
A 0	22.0	5.78	27.8	5.47	16.5	6.08
Average	21.4		26.5		17.0	
0.5	20.4	6.40	22.9	6.23	16.7	6.37
B 0.5	19.6	6.44	24.3	6.15	16.3	6.40
Average	20.0		23.6		16.5	
1.0	19.7	6.54	20.4	6.77	16.4	6.98
C 1.0	17.7	6.61	23.0	6.57	14.6	7.03
Average	18.7		21.7		15.5	
2.0	17.3	7.16	19.9	6.93	16.1	7.15
D 2.0	16.5	7.20	23.1	6.66	13.9	7.35
Average	16.9		21.5		15.2	
3.0	15.9	7.74	19.3	7.81	15.0	7.50
E 3.0	16.3	7.55	19.1	7.89	13.8	7.54
Average	16.1		19.2		14.4	
4.0	15.2	7.87	19.1	7.84	14.9	7.82
F 4.0	15.4	7.87	18.3	7.98	13.1	8.09
Average	15.3		18.7		14.0	
5.0	13.9	8.60	16.1	8.21	13.3	8.14
G 5.0	15.3	8.47	15.9	8.24	11.7	8.35
Average	14.6		16.0		12.5	

Influence of Time and Temperature of Baking Upon the Properties of Cookies

Baking experiments were next conducted in which the temperature of the oven and the time of baking were the variables. The same formula was employed throughout, with the sodium bicarbonate dosage held at 3 grams to the batch. The temperature was varied from 400°F. (204°C.) to 550°F. (288°C.), by intervals of 25°F., or seven temperatures in all. Several baking intervals were included at each temperature, but these were regularly decreased as the temperature was increased.

The data in Table II reveal several facts of significance. First, there was a definite tendency toward darker color in the baked cookies as the time of baking was increased. This is what might be anticipated, as it is generally known that the brownest cookies result from extended baking. It is likewise evident that elevation of temperature tends to produce darker colored cookies, as indicated by the decrease in the percentage of light at 540 mμ reflected from the surface. Observations on cookies baked for 5 minutes at different temperatures support this conclusion, the only deviation from this general trend being evidenced by the batch B1, baked for 5 minutes at 425°F.

These data also disclose the fact that the relative degree of alkalinity (as pH) tends to diminish with an increase in the time of baking. There were two exceptions to this trend, namely, the batches baked at 450°F. (232°C.) and 500°F. (260°C.). It appears, in general, that when cookie dough containing more sodium bicarbonate than is required to neutralize the acids of the dough is placed in the oven, the degree of alkalinity or pH value tends to rise, owing to conversion of the bicarbonate into carbonate. The pH value passes through a maximum when this conversion is complete and then tends to diminish, presumably owing to the reactions set up with the sugars in the presence of this alkali. This is in accordance with the observation of Nef (1913) and is supported by the observations of Johnson and Bailey (1924) upon reheated crackers.

These experiments, involving temperature and time of baking as variables, justify the conclusion that in any comparative study of the effect of the ingredients of the cookie batch upon the color and H-ion concentration of the resulting products, it is very essential that the time and all physical manipulations be controlled with great precision in order to obtain comparative values.

TABLE II

EFFECT OF TIME AND TEMPERATURE OF BAKING UPON COLOR AND H-ION CONCENTRATION OF COOKIES

		Baked at 400° F. (204° C.)				Baked at 425° F. (218° C.)	
	Time of baking	Reflection at 540 mμ	pH		Time of baking	Reflection at 540 mμ	pH
	min.	per cent			min.	per cent	
A 1	5	25.6	8.97	B 1	5	27.4	8.01
A 1	5	23.7	9.04	B 1	5	25.2	8.14
A 2	10	22.1	7.64	B 2	10	19.4	7.43
A 2	10	22.1	7.77	B 2	10	17.8	7.67
A 3	15	14.8	7.45	B 3	15	16.0	6.96
A 3	15	15.0	7.28	B 3	15	15.6	7.03
A 4	20	13.9	6.83				
A 4	20	15.5	6.71				

		Baked at 450° F. (232° C.)				Baked at 475° F. (246° C.)	
	Time of baking	Reflection at 540 mμ	pH		Time of baking	Reflection at 540 mμ	pH
	min.	per cent			min.	per cent	
C 1	4	25.3	7.38	D 1	3	22.1	8.70
C 1	4	24.5	7.32	D 1	3	25.9	8.57
C 2	5	19.9	7.64	D 2	4	18.3	8.28
C 2	5	19.2	7.67	D 2	4	18.5	8.25
C 3	6	16.7	8.14	D 3	5	17.3	8.06
C 3	6	16.1	8.21	D 3	5	18.5	7.87
C 4	7	15.8	8.09	D 4	6	15.1	7.77
C 4	7	15.3	8.11	D 4	6	16.3	7.64
C 5	8	12.5	6.81	D 5	7	13.9	7.55
C 5	8	12.7	6.69	D 5	7	15.4	7.42

		Baked at 500° F. (260° C.)				Baked at 525° F. (274° C.)	
	Time of baking	Reflection at 540 mμ	pH		Time of baking	Reflection at 540 mμ	pH
	min.	per cent			min.	per cent	
E 1	2	22.5	8.31	F 1	2	22.2	8.55
E 1	2	22.8	8.23	F 1	2	22.6	8.55
E 2	3	20.3	8.55	F 2	3	21.4	8.51
E 2	3	21.6	8.48	F 2	3	23.1	8.48
E 3	4	18.4	7.89	F 3	4	19.5	8.31
E 3	4	17.2	8.16	F 3	4	20.8	8.18
E 4	5	12.3	7.60	F 4	5	12.6	7.32
E 4	5	12.4	7.52	F 4	5	12.2	7.57

		Baked at 550° F. (288° C.)	
	Time of baking	Reflection at 540 mμ	pH
	min.	per cent	
G 1	2	23.1	8.36
G 1	2	23.4	8.23
G 2	3	15.9	8.18
G 2	3	17.3	8.06
G 3	4	14.6	7.62
G 3	4	14.0	7.72
G 4	5	8.9	7.45
G 4	5	10.1	7.37

Summary

Color of baked cookies, as measured spectrophotometrically, is related in a measure to the color of the molasses used in the formula.

Dosage of sodium bicarbonate likewise exerts a substantial effect upon the color of the cookies, tending to cause them to brown, or take on a darker hue, as the quantity increased through the ordinary working proportions.

Increasing the temperature at which the cookies are baked tends to increase the depth of color, or reduce the percentage of light reflected from their surface.

Degree of alkalinity of the baked cookies is a function of (a) dosage of sodium bicarbonate used, and (b) time and temperature of baking. In general, the degree of alkalinity (as pH) tends to increase with increase in the sodium bicarbonate dosage. When the normal or optimum dosage of sodium bicarbonate (3 grams per 220 grams of flour) was used, it appeared that the OH^--ion concentration (and hence the pH value) tended to rise in the early stages of baking. This was followed by a decrease in the same values, owing, probably, to the formation of acid-reacting compounds from the sugars present, which in turn either served as buffers or tended to neutralize the alkali present.

Acknowledgment

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REPORT OF THE COMMITTEE ON METHODS OF ANALYSIS

By D. A. COLEMAN, Chairman
United States Department of Agriculture, Washington, D. C.

(Read at the Convention, June 5, 1928)

This year, the committee consisted of D. A. Coleman, chairman, H. C. Fellows, Rolfe Frey, C. W. Ingman, and C. B. Morison.

The committee offers for its major activity this year the publication and distribution of the Book of Methods of Analysis. As most of you own or have at your disposal a copy of this book, it is not necessary to describe its nature or scope. Anyone who desires to see the book or purchase a copy may do so by interviewing the secretary.

Likewise, I will not take your time discussing the financing of this book. Suffice it to say that over four-fifths of the original edition have been sold and that with the payment of all current subscriptions the entire project will have been accomplished without expense to the association, adding, also, a small profit to the treasury. Now that the baking test has been adopted as a tentative method of study by this association it is planned to send to all subscribers Table 21, "Weights of Flour Corresponding to 85 Grams of Dry Matter at Various Moisture Contents," for use in determining the correct amount of flour to be used in the experimental baking test.

I recommend that those who do not have a copy of the book and are planning to purchase one do so without delay, because less than 60 copies are now unsold, and a reprint is not contemplated, at least not soon.

Collaborative Studies

Protein Studies

Altho the making of protein tests on wheat has been the subject of study and discussion before this association for several years, perhaps so much so that it is becoming a trite subject, it appears from the evidence submitted and the agitation started for federal supervision of protein testing laboratories that the manner in which protein tests are made, particularly the accuracy with which different laboratories are expected to agree, is in considerable confusion.

At the 1925 convention, this association went on record as recommending 0.25 per cent as an allowable error between different laboratories. No recommendation seems to have been made, however, as to just how this tolerance should be applied, that is,

whether the factor 0.25 should be added to as well as subtracted from a submitted value, making the total allowable range of error as 0.5 per cent, or whether the factor 0.25 should be divided into two parts, using 0.12 per cent as a tolerance below the submitted value and 0.13 per cent as a tolerance above the submitted value.

In 1926, using the last mentioned procedure, approximately 78 per cent of the collaborators obtained results that would meet the last named conditions; whereas exactly 96 per cent of the collaborators were able to make tests that met the first mentioned tolerance. Neither of these tolerances, however, meet the refinement that is expected by the grain trade, and it was with the view of determining again what can be expected of reputable chemists in agreeing on the protein content of a sample of wheat that this year's collaborative studies on protein determinations were undertaken.

For this purpose two wheats of exactly opposite physical characteristics were chosen. One was a sample of red durum wheat, very difficult to grind and of moderately high protein content; the other was a white wheat of low protein content and easy to prepare for analysis.

Two portions of the same sample were submitted for analysis. One was ground, the other was not ground. It was hoped in this way to obtain some information regarding the relation of the preparation of the sample to the accuracy with which the protein determination could be made. These wheats, prepared as above described, were submitted to 40 representative cereal chemists, with the request that protein tests be made upon them, as well as a moisture determination, the latter by the 130° C. air-oven method. The unground durum wheat was sent out labeled "durum," the ground portion was labeled "hard red spring." The white wheat carried the label "white" and the ground portion was labeled "hard red winter."

Upon receipt of the moisture and protein results, the data were converted to a 13.5 per cent moisture basis and it is on this basis that the figures in Table I are given.

An examination of Table I shows that all of the forty collaborators were able to agree within a tolerance of 0.5 per cent. If, however, the data are examined more critically, it will be found that if the 0.25 per cent tolerance is divided into two parts as outlined above, as an average of the four samples tested, 75 per cent of the collaborators were able to agree upon the protein content. This is about the same average as was obtained last year.

TABLE I

Protein Content of Wheat as Reported by Different Collaborators
Influence of Preparation of Sample on Result

Collaborator	Durum whole seed	Durum ground	White whole seed	White ground
	per cent	per cent	per cent	per cent
H. C. Barker	12.15	12.25	9.77	9.74
M. J. Blish	12.48	12.40	9.87	9.95
F. W. Bliss	12.32	12.43	9.90	9.93
A. Christie	12.28	12.34	9.84	9.90
C. G. Colcord	12.21	12.20	9.77	9.82
R. J. Clark	....	12.16	...	9.79
F. A. Collatz	12.03	12.47	9.80	9.84
H. B. Dixon	12.18	12.25	9.85	9.70
R. K. Durham	12.14	12.20	9.77	9.72
L. E. Earlenbaugh	12.30	12.59	9.77	9.98
H. C. Fellows	12.21	12.16	9.80	9.73
J. T. Flohil	12.21	12.35	9.81	9.94
C. H. Foster	12.37	12.46	10.02	9.94
Rolfe Frey	12.31	12.48	9.86	9.82
W. L. Glasgow	12.21	12.51	9.81	9.94
Edward Gookins	12.10	12.18	9.62	9.73
Wm. Heald	12.20	12.30	9.91	9.90
Raymond Hertwig	12.34	12.26	10.01	9.74
H. H. Johnson	12.24	12.30	9.85	9.76
A. A. Jones	12.07	12.25	9.83	9.85
J. P. Lewis	12.43	12.41	9.91	9.90
Fred Lumsden	12.37	12.49	9.98	9.91
C. E. Mangels	12.25	12.38	9.95	9.93
W. C. Meyer	12.40	12.42	9.78	9.71
M. D. Mize	12.12	12.38	9.83	9.83
L. H. Patten	12.39	12.44	9.97	9.93
E. C. Paulsel	12.36	12.42	10.01	10.16
R. R. Pitts	12.21	12.26	9.88	9.78
A. A. Sasse	12.42	12.39	9.76	9.79
O. C. Shermer	12.42	12.47	9.94	10.05
R. C. Sherwood	12.29	12.45	9.96	10.02
Betty Sullivan	12.32	12.43	9.93	9.94
E. A. Tibbling	12.50	12.54	10.06	10.03
— — Thompson	12.07	12.36	9.91	9.89
E. L. Van Eschon	12.29	12.42	10.02	10.00
H. E. Weaver	12.29	12.27	9.96	9.98
L. D. Whiting	12.08	12.08	9.70	9.85
A. D. Wilhoit	12.42	12.41	9.86	9.88
Floyd Woosley	12.26	12.28	9.95	9.74
W. B. Young	12.28	12.45	9.91	9.98
Average	12.27	12.36	9.88	9.88
High	12.50	12.59	10.06	10.16
Low	12.03	12.08	9.62	9.70
Range	0.47	0.51	0.44	0.46

Efforts were then made to determine why the other 25 per cent of the collaborators were not in line, whether it was because of non-uniformity of the sample, equipment difficulties, or standard test solutions. In order to determine if the average range in protein content, 0.47 per cent, was influenced by variations in the protein content of the four samples of wheat analyzed by the forty collaborators, all four samples were analyzed 40 *dif-*

ferent times by a reliable chemist. That is to say, forty separate portions of the durum wheat and the white wheat were ground and tested for protein and moisture by the same operator using the same equipment and standard solutions throughout. Likewise, a bulk sample of each of the two wheats was ground, divided into 40 different parts, and analyzed for moisture and protein content. All results were calculated to a 13.5 per cent moisture basis. The results of these tests are given in Table II.

TABLE II

VARIATIONS ENCOUNTERED IN ANALYZING 40 SEPARATE SAMPLES OF WHEAT

Nature of Sample	Av. protein content	Highest protein content	Lowest protein content	Range in protein content	Variations from average percentage of protein found				
					0.-0.5*	0.21-.25	0.16-.20	0.11-.15	0.06-.10
	per cent	per cent	per cent	per cent					
Whole durum	12.26	12.38	12.08	0.30	57.5	30.0	7.5	5.0	...
Ground durum	12.29	12.43	12.17	.26	80.0	15.0	5.0	...	...
Whole white	9.86	10.01	9.69	.32	40.0	32.5	20.0	2.5	5.0
Ground white	9.80	9.88	9.71	.19	75.0	25.0	...	...	...
Average				0.27					

*Per cent of total tests made.

In Table II it will be seen that an average of 0.27 per cent was obtained by this analyst while making 40 distinct tests on all four of these samples of wheat. The greatest variation was 0.32 per cent, and was obtained from the analysis of the unground sample of white wheat. The lowest variation, 0.19 per cent, was obtained with the ground sample of white wheat. Considering that the same procedure was used throughout, it seems justifiable to state that this variation in protein content is inherent in the sample and is not the result of the personal equation of the analyst. To obtain further proof of this, however, aliquot portions of an ammonium sulphate solution, in which there could be no variation in nitrogen, were digested and distilled as were the wheat samples and in no instance was the error greater than 0.05 per cent. In 98 per cent of the tests the nitrogen as determined was identical. The conclusion to be drawn, therefore, on a very conservative basis, is that the protein content of a bulk lot of wheat can be expected to vary by at least 0.20 per cent. These tests were made on samples of wheat prepared for analysis in the most careful manner and analyses were carried out with the thought of uttermost accuracy. It is not unfair to speculate, therefore, that under less rigid conditions a greater variation in results will obtain. No doubt some of the collaborators who were not included in the 75 per cent of satisfactory workers obtained portions of the sample with slight variations. Others, however, cannot be excused on this ground and we must look to another source.

A check of the equipment and standard solutions was next tried. To the secretary of the local sections at Kansas City, Omaha, Minneapolis, and St. Louis, previously dried and tested ammonium sulphate was sent with the request that a 0.5 per cent solution be made of this salt, and that from this solution 25-cc. aliquots be removed and the nitrogen content determined in the regular manner of making a protein test. It was further requested that the same size of aliquot, 25 cc., be used and the nitrogen content determined by distillation only after the addition of alkali; i.e., without previously digesting. If the results by the two procedures did not agree it could be said that lack of concordant results was in the equipment. The results of these tests showed that this was not the case, however, as in only one instance out of 22 was the difference in the nitrogen, calculated as protein (N×5.7) content of the 25 cc. aliquot after digesting in the usual way and by distilling direct, greater than 0.10 per cent. These data are shown in Table III.

TABLE III

PROTEIN (N X 5.7) AS DETERMINED BY VARIOUS COLLABORATORS ON A 0.5 PER CENT AMMONIUM SULPHATE SOLUTION

Collaborator	By digesting and distilling	By distillation only	Difference
	per cent	per cent	per cent
H. C. Baker	14.68	14.68	0.00
F. W. Bliss	14.90	15.00	.10
R. J. Clark	15.00	15.00	.00
F. A. Collatz	15.05	15.03	.02
L. E. Earlenbaugh	15.00	15.07	.07
J. T. Flohil	15.10	15.00	.10
Rolfe Frey	15.02	14.98	.04
W. L. Glasgow	15.00	15.00	.00
Edward Gookins	14.88	14.71	.17
H. H. Johnson	14.73	14.73	.00
A. A. Jones	14.72	14.70	.02
Fred Lumsden	15.00	15.00	.00
W. C. Meyer	14.99	15.08	.09
M. D. Mize	15.04	15.00	.04
E. C. Paulsel	14.80	14.75	.05
A. A. Sasse	14.99	15.10	.11
O. C. Shermer	14.90	14.90	.00
Betty Sullivan	14.85	14.85	.00
E. A. Tibbling	15.00	15.00	.00
H. E. Weaver	14.88	14.82	.06
A. D. Wilhoit	15.20	15.20	.00
W. B. Young	15.00	15.00	0.00
Average	14.94	14.94	0.04
High	15.20	15.20	.17
Low	14.68	14.68	.00
Range	0.52	0.52	0.17

On the other hand, there was a distinct difference in the nitrogen or protein content of a 25 cc. aliquot of 0.5 per cent solution of ammonium sulphate as reported by the twenty-five collaborators. The lowest value reported was 14.68 per cent and the highest 15.20 per cent, the range being 0.52 per cent. From a theoretical standpoint the nitrogen content found should have been 15.08 per cent. The differences given, therefore, indicate one of two things: first, that the standard solutions were slightly off; or, second, that an error was made in preparing and subdividing the solution of ammonium sulphate. Altho it is not possible to say so definitely, there is a strong indication that some of the standard solutions were off, as in several instances low results were reported from collaborators who also reported low results from the analysis of the ammonium sulphate.

It appears, therefore, from an examination of this season's protein activities, as well as those of previous years, that it is going to be very difficult to live up to the 0.25 per cent error recommended by this association if this error is to be interpreted in the usual way. Agreement between collaborators over several years has never been less than 0.5 per cent, in some years it has been even greater than this. Part of this error has been shown to be inherent within the sample itself. The magnitude of this variation has been shown to be almost the equivalent of our present accepted experimental error.

It is believed to be time that an interpretation be given to our value for experimental error. If the interpretation is such that this value is to be doubled for the purpose of obtaining concordant results, this association is in a satisfactory position as far as protein testing is concerned. On the other hand, if the error is to be halved, it is doubtful whether satisfactory agreements will be frequent.

Analysis of Feeding Stuffs

As a new study this year the committee started a collaborative program on the analysis of feeding stuffs. A sample of bran and one of shorts were used and the usual routine tests made on such material were undertaken, following the directions given in the Book of Methods. Samples were sent to twelve collaborators and returns were made by eight. The results of their tests are given in Tables IV and V.

Coincident with the sending out of these samples, tests were made relative to their uniformity. The variations found from the

analysis of 30 aliquot portions of the material are given in the next to the bottom line of the table in each instance. Likewise the corrected range in results, which takes into consideration the variation in the composition of the sample, is given.

TABLE IV
Results of Tests Made by Nine Collaborators on a Sample of Shorts

Collaborator	Moisture	Basis 13.5 per cent moisture Ash	Fat	Fiber	Protein
	per cent	per cent	per cent	per cent	per cent
C. G. Colcord	9.43	2.80	4.15	...	14.51
J. T. Flohil	9.89	2.86	4.16	3.94	14.74
M. D. Mize	9.55	2.76	4.28	3.28	14.56
H. H. Johnson	9.79	2.76	4.34	3.41	14.57
E. C. Paulsel	10.00	2.84	4.33	3.49	14.61
E. A. Tibbling	9.94	2.77	4.35	3.90	14.76
A. D. Wilhoit	9.85	2.78	4.32	3.17	14.59
Floyd Woosley	9.60	2.79	4.89	2.72	14.23
W. L. Heald	10.15	2.84	5.05	3.29	14.39
Average	9.80	2.80	4.43	3.40	14.55
High	10.15	2.86	5.05	3.94	14.76
Low	9.43	2.76	4.15	2.72	14.23
Range	0.72	0.10	0.90	1.22	0.53
Variation in results due to condition of sample (30 tests)	0.36	0.14	0.33	...	0.32
Corrected range in results....	0.36	—0.04	0.56	...	0.21

Table IV shows that only with the analysis of protein and ash in shorts were the collaborators in an entirely satisfactory position. Seven of the nine collaborators reported fat results that were quite satisfactory. The greatest differences were experienced in determining fiber and moisture, the poorest showing being recorded on the fiber analysis.

TABLE V
Results of Tests Made by Nine Collaborators on ,a Sample of Bran

Collaborator	Moisture	Basis 13.5 per cent moisture Ash	Fat	Fiber	Protein
	per cent	per cent	per cent	per cent	per cent
H. B. Dixon	9.38	6.02	3.80	...	13.32
J. T. Flohil	9.25	6.00	3.72	9.30	13.58
E. C. Paulsel	9.50	6.38	3.87	10.31	13.48
E. A. Tibbling	9.26	6.01	4.03	9.87	13.71
A. D. Wilhoit	9.35	5.96	3.77	9.02	13.46
M. D. Mize	8.99	6.02	2.42	9.31	13.34
H. H. Johnson	9.11	5.96	3.28	9.71	13.45
Floyd Woosley	9.00	6.00	2.69	8.09	13.35
W. L. Heald	9.55	6.09	2.54	10.57	13.32
Average	9.27	6.00	3.34	9.46	13.44
High	9.55	6.38	4.03	10.57	13.71
Low	8.99	5.96	2.42	9.02	13.32
Range	0.56	0.42	1.61	1.55	0.39
Variation in results due to condition of sample	0.36	0.14	0.33	...	0.32
Corrected range in results....	0.20	0.28	1.28	...	0.07

A somewhat similar situation is true regarding the analysis of the sample of bran. With this commodity, satisfactory agreements were obtained by all collaborators on the determination of protein. With the exception of one, this is also true of the ash and moisture determinations. Results of fiber determinations on this commodity were also unsatisfactory, as the range in results was well over 1 per cent.

Recommendations

1. That this association go on record as interpreting the tolerance to be permitted in making protein determinations.
2. That further collaborative work be continued on feeding stuffs.
3. That new collaborative studies be started relative to the analysis of milk and milk products.

REPORT OF COMMITTEE ON STANDARDIZATION OF EXPERIMENTAL BAKING TEST

Present Status of Standard Experimental Baking Test[1]

By M. J. Blish, Chairman

Department of Agricultural Chemistry, University of Nebraska, Lincoln

(Read at the Convention, June 5, 1928)

A definite and specific experimental baking procedure has been proposed by the committee as a tentative standard method (1928). This is merely a beginning. The ultimate *establishment* of the method, either in its present or a modified form, is the all-important move which must now be contemplated. Hasty comments and criticisms of all kinds and descriptions are inevitable, as the proposed method undoubtedly violates the established and cherished traditions of a large number of cereal chemists. The situation calls for a critical analysis and a careful and unprejudiced consideration of the facts.

It must be thoroly appreciated at the outset that the standardization of this test offers certain difficulties and stumbling blocks which are not ordinarily encountered with tests of a more strictly and exclusively chemical or mechanical nature. In accordance with the customary and conventional procedure in matters of this kind, a method is proposed as tentative only after the successful completion of an extended series of collaborative tests conducted by different workers in different laboratories. With the baking test this sort of procedure is impracticable if not impossible. The reason for this is real, even tho it may not be obvious to all. It is that cereal laboratories, as a group, do not have equipment and facilities that are adequate for an undertaking of this character. There is an astonishing variation among individual laboratories as to such items as mixers, ovens, dimensions of pans and fermentation bowls or jars, and facilities for securing indisputable precision and uniformity in temperature conditions. There are too many well known and highly respected laboratories that do not even have precise automatic temperature control, either for dough fermentation or for baking, but control is merely approximated by the alternate turning on and off of electrical

[1] Published with the approval of the director as Paper No. 59, Journal Series, Nebraska Agricultural Experiment Station.

switches. There is need for greater refinement in our laboratory appliances for controlling environmental conditions.

The expectation of close agreement among results of collaborative tests is, of course, inversely proportional to the complexity of the material, to the number of factors involved in the test, and to the extent to which the personal element enters into the procedure. Unfortunately, all of these factors are combined to a high degree in the baking test. This condition demands that special emphasis be placed upon the extreme necessity of a rigidly fixed set of specifications for all items and phases of the test, and a religious adherence to these specifications, in order to meet the requirements of a standard test that is worthy of the name.

Briefly stated, we have, on the one hand, a test that exceeds all others in its demands for a complete and definite set of specifications, owing to its inherent complexity. On the other hand, we are faced with the most unfavorable conditions imaginable for the uniform *adherence* to any rigid set of specifications that might be proposed, owing to variable laboratory equipment and to lack of proper facilities for precise and uniform control of environmental conditions. Furthermore, the situation has been unfortunately complicated by the complete absence of any appropriate or suitable means for scoring and reporting results in terms of common understanding. Under such circumstances, satisfactory collaborative tests can hardly be considered seriously unless conducted in the same laboratory and with the same equipment.

The foregoing is not merely an unverified opinion on the part of the writer, but it has been demonstrated in a fairly convincing manner. One phase of this demonstration occurred during the meeting of the committee held at Lincoln in January, 1927. Collaborative tests with two samples of flour were carried out in one laboratory by eight workers, using a procedure not essentially different from the proposed (1928) method. The results of this experiment have been briefly cited in a previous report (1927), but they will bear repeating. Six of the workers were using the procedure for the first time, one was highly experienced. The results of each operator clearly brought out the same differences in the characteristiccs of the two flours. Furthermore, the remarkable concordance among the different operators was convincing to the most skeptical among those present. The loaves of the most experienced worker in the group could not be distinguished from the entire lot, altho such an attempt was made by an impartial, tho critical,

referee. This experience leaves little room for doubt as to what can be accomplished by the use of a fixed method, with properly controlled conditions, and with all operators using the same equipment and manipulation.

Recently, some collaborative tests have been undertaken, both within the committee and elsewhere, using methods "approximating," as nearly as possible under available conditions, the recently proposed method (1928). In these tests, samples of the same flour were sent to various laboratories. The results in some instances were very discordant, and in certain quarters they have been made the basis of adverse criticism, if not of actual condemnation, of the method as a possible standard procedure. Conclusions of this kind are premature and based upon false premises. By no stretch of the imagination can these collaborative tests be regarded as having been conducted under fixed and uniform conditions, even tho it be granted that the same formula and pan dimensions were used by all. Varying methods of mixing, punching, and molding certainly were [redacted] used, as specifications for these items had not been officially proposed, or even agreed upon by the committee at the time. It is also certain that there were different degrees of accuracy in temperature control, for both fermentation and baking. There could have been no uniform scoring system.

A brief summarizing of the results of collaborative efforts involving a fixed procedure discloses two outstanding and significant facts: (1) Such tests, when performed by different individuals in the same laboratory, with the same equipment, procedure, and environmental conditions, yielded concordant and highly satisfactory results, even with inexperienced operators. (2) Individuals working in different laboratories, with only partially uniform conditions, obtained discordant results. These two facts permit of but one reasonable interpretation—that the latter series of tests were not conducted under fixed and uniform conditions, and therefore cannot be regarded as tests of a fixed procedure, in the true sense of the term. However, when tests are conducted under identical conditions, excellent results may be obtained. In our present status it appears to be almost impossible to obtain uniformly fixed conditions unless the collaborative tests are performed in the same laboratory.

In view of these circumstances, it has not been expedient for the committee to attempt to use the strictly conventional and customary collaborative procedure as a basis for the recommendation of the recently proposed method (1928). It has—as has

been emphasized in previous reports—been necessary, first of all, to reach substantial agreement as to the adoption of certain principles which are ordinarily regarded as fundamental to a standard scientific test of any material, but which are and have been habitually violated in laboratory test baking. There should be no necessity for any re-statement of these principles. However, there is in this connection a situation which must be seriously taken into account. This is the fact that altho cereal chemists generally admit that the principles of the fixed and specified procedure are fundamentally sound, and must inevitably be the basis of any *standard* method, there are apparently many who will hesitate to "go the limit" in the application of these principles, in spite of the fact that the very nature and complexity of the baking test demands the strictest possible adherence to them. The committee, however, after much consideration and discussion, has unqualifiedly endorsed the idea that it is only upon these principles that a standard laboratory baking test can ultimately be established.

The necessity of strict compliance with these requirements having been agreed upon, the next order of business has been the selection and recommendation of the specifications for the method itself. Altho *any* arbitrarily fixed procedure might conceivably meet the basic requirements that have been outlined and endorsed by the committee, there are other conditions which the method must fulfil. It must be designed to allow a reasonably wide range within which even minor differences in flour characteristics will manifest themselves. It must offer a sound basis for the differentiation of flour characteristics in terms of commercial utility. In addition to these features, the method should combine maximum simplicity of operation with a minimum demand for complicated, highly specialized and expensive apparatus. To again summarize: In the recommendation of a tentative standard procedure, there are three items which demand major emphasis: (1) It must be fixed in order to be standard. (2) It must be interpretable in order to be useful. (3) It must be simple and economical, in the interests of maximum conservation of time, labor, and equipment.

For a number of years, a method has existed in which all of the foregoing requirements are fulfilled to a degree which can hardly be improved upon, except by the probable future development of better mechanical facilities, such as standard laboratory mixers and molders, respectively. This is a method whose essential features have been described by Werner (1925), and which, as he states, has been founded, with considerable modification, upon

a procedure reported by Maurizio, in 1903, in his published work "Getreide, Mehl und Brot." This method, with minor modifications, has been proposed and recommended by the committee as a tentative "Basic Standard Procedure" (1928). This recommendation has been based upon as thoro and careful a consideration and study of the method and its possibilities as time, financial resources, and facilities would permit.

With the basic standard procedure as a foundation and reference point, provision has been made for certain additional or supplementary tests. These tests deal individually and respectively with the several factors with which one is likely to be chiefly concerned when testing flour as to its quality or utility, and a brief consideration of them is appropriate at this point. These supplementary tests are designated respectively by the letters A, B, C, and D.

Test "A" takes into account variations among flours as to water absorbing capacity. It is believed that the recommended absorption is appropriate for most bread flours, altho some flours cannot be satisfactorily tested on the basis specified in the basic procedure.

Test "B" obviously provides an opportunity for studying the behavior of flour under varying fermentation periods. This supplementary test is included in the belief that the importance of this quality factor is too frequently underestimated by the cereal technologist.

Test "C," involving additions of specified increments of potassium bromate, is regarded by those who have used it extensively as highly informative and valuable for practical purposes. Such a test of a flour's tolerance and behavior toward oxidizing agents takes into account certain well known and firmly established commercial practices (bleaching and the use of some "yeast foods") which have a profound influence upon flour and bread characteristics. Experienced users of this test are convinced that the bromate test supplies a means for the estimation of strength, tolerance, and stability of gluten, and that to the experienced operator, therefore, it provides a convenient and valuable index to that elusive factor called "gluten quality," as well as a means for controlling this important factor in flour and bread production. Discussions of various aspects of the "bromate differential test" (originated as such by E. E. Werner) have been published by Werner and Herman (1928), by Herman (1927), and by Blish and Sandstedt (1927). The practical utility of this feature of the proposed

standard baking procedure has been established beyond any reasonable doubt.

Test "D" is included in recognition of the knowledge that bread characteristics may be profoundly influenced by varying degrees of mixing, and occasions may arise which demand that this factor be taken into account. Certain phases of this situation have been dealt with by Swanson and Working (1926).

As previously indicated, the critical point of the entire project is now at hand, and the ultimate adoption and establishment of the proposed standard method involves a situation which must be faced from all possible viewpoints, hence this detailed discussion. At this point it is worth while to discuss briefly certain objections and criticisms in regard to the proposed standard method, which have been and will be encountered.

There appears to be a widespread feeling among cereal chemists that the adoption of the proposed standard procedure would compel laboratory technicians to *immediately* abandon all other methods and conform strictly to the standard specifications, even in the most ordinary routine testing. This is a mistaken idea. Such a drastic and immediate step is inconceivable, especially in view of the fact that the method carries with it no police or executive authority. The standard method is intended primarily to serve as a "reference" method, for use chiefly when cereal chemists have occasion to meet on grounds of common understanding and common interest. This in itself is of a consequence sufficient to justify a standardization of the most important of all our laboratory flour tests. It is sincerely hoped that the standard test will eventually come into a wider usefulness than merely that of an occasional reference test, and that, in its more essential features at any rate, it will ultimately be adopted for general use, both in research and in industrial application. Such a fortunate outcome would offer advantages too numerous to even mention within the scope of this paper. However, it is manifestly impossible to reach this condition in one jump. It is just as certain that the goal will never be reached unless a start is made.

It is true that a general adoption of the proposed test will necessitate the purchase of additional equipment by the majority of cereal laboratories. In this connection the most serious consideration is the requirement for precise temperature control, both in fermentation and baking. In many instances the situation will demand the acquisition either of new ovens or of means for securing precision in the control of temperature in the old ones. A

general move of this kind is by no means as simple and obvious as it might appear, for it means the overcoming of much mental, physical, and financial inertia. This condition of affairs, however, cannot fairly be applied specifically as a criticism of the proposed (1928) test. No *standard* baking test can be proposed, or even imagined, which will not be equally exacting in these requirements, which *must* be generally complied with if the standard test is to become anything more than a mere state of mind.

The matter of the general establishment and use of the proposed test (1928) presents one especially difficult, tho critical, aspect, which is perhaps the key to the entire situation. This is the fact that a large group of cereal chemists and technologists will not feel disposed to exert themselves to secure and properly install the apparatus and facilities necessary for the proper performance of the proposed (1928) test until its adoption and establishment are assured beyond all reasonable doubt. This attitude, if maintained by a majority, would in itself prevent or indefinitely postpone the general establishment of *any* standard baking test. Any widespread adoption of the proposed method must be preceded by a general familiarity with it. One must use the test in order to gain this familiarity, and one cannot use the test without first having the proper equipment, facilities, and experience. Thus, by postponing our efforts to familiarize ourselves with the test until its adoption is assured, we are merely preventing the assurance of adoption; thereby chasing ourselves around a circle, and simply defeating our own purpose.

To be sure, a true scientist is expected to maintain an attitude of conservatism, if not skepticism, toward the acceptance and adoption of a new or untried method, unless there is an abundance of convincing evidence to show that it will answer the purpose for which it is intended. To paraphrase the slogan of the florists, the war-cry of the scientist is "say it with data." This, in the case of a proposed *standard method,* ordinarily means *collaborative* data. As has been shown, however, the conditions for obtaining such data in the case of the standard baking test are limited at present. In the final analysis, then, the project has inevitably reached the point where its success or failure will depend upon nothing more or less than a reasonable amount of faith in the committee and in others who have given largely of their time, energy, and funds in the interest of the project. It should also be remembered that the proposed method is neither new nor untried. Enough of its features have been successfully employed for many

years by men of high scientific attainment and of undisputed professional qualifications to guarantee its value and merit.

There is another basis for objecting to the fixed procedure that, unfortunately, cannot be disregarded at this time. This is the inevitable possibility of an inclination to allow commercial and individual prejudices to assert themselves. In analyzing objections of this type it may be found that their origin is two-fold. One type originates from those who have never practiced the test under proper conditions and the other from those who may be familiar with it and find it objectionable from the standpoint of their commercial interests. From the latter viewpoint one of the major objections may conceivably arise from the fact that the test is brutally frank and paints a picture of the flour as it really is, rather than as it may appear after the skill of the artisan has been brought into play. The bromate differential test may be disliked by some because it exposes certain artifices now practiced by the miller for which heretofore no convenient method of ascertainment has been available. This test removes some of the mystery which shrouds the artificial changing of the characteristic nature of flour by means of certain methods of bleaching and treating. To this extent it goes a long way toward the removal of the smoke screen under which flour is frequently manufactured and sold. It is for the cereal chemists as a group to decide whether or not they wish to adopt methods of flour testing which will distinguish between inherent flour characteristics and manifestations due largely to manipulation by the flour manufacturer.

It may be worth while to consider the possibility of certain important consequences of this test aside from the mere information it offers to the technologist. This is the bringing together of the buyer and seller upon a basis of common understanding. It will, potentially at any rate, enable them to converse with each other more intelligently than heretofore and should certainly operate toward minimizing the risk which the flour buyer assumes under the principle of "let the buyer beware." This phase of the discussion may be summed up by the assertion that the proposed method involving the bromate differential test is capable of disclosing first, the character of the wheat ground by the miller, and second, certain practices in which the miller may indulge for the purpose of altering the characteristics of this wheat. In addition to this it enables the buyer to establish definite criteria for his purchases. If these aspects of the test are objectionable to cereal

chemists as an organization, then it is strongly recommended that they reject it entirely.

Disregarding for the moment the various commercial aspects of the test, it is well to give brief consideration to the agronomists, plant breeders, and other agricultural workers who are continually striving toward the development of better varieties of wheat. Perhaps this situation can be dealt with best by citing a concrete example. At a certain well known agricultural experiment station an agronomist has been attempting the precise ascertainment of the utility of a new and promising strain of wheat which has been developed at that station by methods of plant breeding. Among other things he has deemed it necessary to establish definite knowledge as to the baking quality of this selected variety. He submitted a representative sample of flour ground from this wheat together with a sample of a well known and established variety to supposedly qualified cereal chemists in order to obtain definite knowledge as to the comparative baking qualities of these two varieties. To his dismay the reports received from the various laboratories were decidedly conflicting. Opinion was about equally divided as to the relative merits of the two wheats. As the result of this experience the agronomist enters the just complaint that no confidence can be placed in the present-day laboratory methods for the ascertainment of baking quality in wheats. He rightfully asks the question: "Upon whom can we rely to furnish dependable information in matters of this kind when supposedly qualified cereal chemists can reach no agreement among themselves?" Other similar, if less conspicuous, instances of this nature might be cited. This is indeed a serious reflection upon the scientific and professional status of cereal chemistry and is a result of the lack of a standard method for the laboratory test baking of flour as well as the absence of a uniform system of reporting results. Thus, as scientists, we do not occupy an enviable position so long as we lack the confidence of fellow-scientists who are working in fields closely allied to our own and who are forced to depend upon us to a considerable degree for important knowledge bearing upon their own problems. In matters of this kind, undoubtedly the chief source of trouble is the tendency to base our reports mainly upon our own personal preferences rather than to confine them exclusively to a statement of flour characteristics with a standard fixed procedure as a common basis for the ascertainment of these characteristics. If it is generally agreed, as seems to be the case, that satisfactory bread may be produced from any sound normal

wheat of standard variety providing the flour is properly handled, is it not absurd to maintain the ancient custom of basing our reports upon individual preferences?

There is greater need for a standard baking test than ever before. This is recognized by practical industrialists, by agronomists and plant breeders, by the editors of our trade journals, and by others not directly engaged in laboratory flour testing. A well known mill owner recently wrote in a letter which was called to the writer's attention, "I notice that in practically all laboratories there is a laxity in respect to the refinements of baking that has to be overcome before any tests can be of real value in a constructive way. I find that our laboratory is quite a problem requiring almost as much attention as our actual milling operations."

Aside from all matters of expediency, however, is it not time for us as cereal chemists to include among our numerous baking methods at least one procedure which treats all flours impartially, and therefore places the burden of proof upon the flour itself, rather than upon the skill or artistry of the operator? May we not elevate our scientific standing and dignity through the adoption of methods which truly and precisely indicate flour characteristics rather than those adopted by personal inclination and influenced by manipulative dexterity? Why not make flour testing a science rather than an art? During the last year or two years many cereal technicians have adopted the proposed test, so far as its important aspects are concerned. There is no indication that those who have given it a fair trial have any intention of abandoning it in favor of previous methods. Failure of its acceptance as a standard method by official organizations will not be likely to cause its discontinuance by those who now practice it, and they will doubtless continue to use it until something approvedly better is offered. If not a precise scientific method, it at least more nearly approaches a scientific approximation than any procedure now available. It is upon this point that the final report of the baking committee is rendered, and not upon the point of convenience to the buyer, seller, manufacturer, or technologist.

The committee recommends the adoption of the proposed method (1928) as a tentative standard experimental baking procedure, by the American Association of Cereal Chemists.

Acknowledgment

The members of the Committee on the Standardization of the Experimental Baking Test deeply appreciate the advice, suggestions, and friendly cooperation of many members of the association in the discussion of the work of the committee. Responsibility for the recommendations of the committee is assumed exclusively by its own personnel. It is the sentiment of the committee that the name of no single individual is to be associated with its recommendations.

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A Comparison of the Proposed A. A. C. C. Baking Test and the Commercial Loaf (350 Grams Flour) Test

By C. H. Bailey, C. C. Fifield, and R. C. Sherwood

A report of comparative baking tests of 21 samples of flour milled from different types of wheat employing two different methods of baking was made by Sherwood and Bailey (1927) as a part of the report of the baking test committee, by Blish (1927). Results of replicated baking tests of a series of 21 flours were discussed.

Following this preliminary study the experiments were continued on the same basis using 30 additional flours. This report covers the results of tests of the total of 51 flours baked by the two methods. Each flour was baked 8 times by the small dough method and 12 times by the large dough method. The study thus involved more than 1000 bakes.

The results of these tests were subjected to statistical study in the manner previously reported. Certain significant figures are given in

Table I. In general, the observations of the preliminary study were confirmed when the experiments were completed. The coefficient of correlation of the loaf volume of bread baked by the two methods was computed. The coefficient was r = +0.53 ± 0.07 for 51 flour samples. For the first 21 samples of the series the coefficient of correlation was found to be r = 0.82 ± 0.05. The value, r, for the tests of the 51 samples, while lower than that for the first 21, is a significant positive correlation. No basis is afforded in these studies for determining which of the two methods of test baking yields results most definitely correlated with the performance of these flours in commercial baking.

TABLE I

SUMMARY OF DATA RECORDED IN COMPARATIVE BAKING TESTS OF 51 FLOURS

	Average of all bakes	
	100 g. loaves replicated 8 times	350 g. loaves replicated 12 times
Loaf volume	444.5	2182.8
Volume per gram	4.44	6.24
Coeff. variation (C. V.)	1.97	3.33
Coeff. correlation of loaf volume by the two baking methods r = +0.53 ±0.07		

The average loaf volume of the tests of the 51 samples was 444.5 cc. in the small doughs, almost identical with the results of the first 21 flours. The average loaf volume of the 51 samples baked as large doughs was 2182.8 cc., 37.6 cc. greater than the average for the first 21 tests.

The ratio between weight of flour and volume of loaf for the entire series confirmed the results of the first 21 baking tests. In the small doughs the volume per gram of flour for the entire series was 4.44 cc. almost identical with the first 21 tests, and the entire series of large doughs, 6.24 cc., compared with 6.13 cc. for the first 21 tests of the series. This difference of 0.11 cc. is not large. These results are considered conclusive evidence that there is a subtantial difference in the volume of loaf per gram of flour when the same flours are baked by the two methods used.

The coefficient of variability was appreciably reduced by the inclusion of a larger number of flours in this comparative study. The relation between the two values obtained by the two baking methods is practically the same as with the preliminary tests. The small dough bakes of the entire series showed a coefficient of variation (C V = 1.97) of 59% of that of the large dough bakes (C V = 3.33), compared with 58% as observed in the first 21 tests. This confirms the statements in the previous report regarding the substantially lower

variability in loaf volume observed when the flours were baked by the small dough procedure.

The final scores for texture and color for the entire series of 51 samples did not differ significantly from the values obtained in the preliminary series and indicated that grain, texture, and color were scored in very nearly the same manner when the flours were baked by the two baking procedures.

No conclusive evidence is afforded from these studies that one method yields better measures of baking quality than the other. On the other hand, there is no indication that the small dough method is in any sense less satisfactory than the large dough method. In fact, such advantages as are evident are attached to the small dough method, particularly in the matter of variability. When small quantities of flour are available, there is the further advantage of the possibility of additional replicates, or of the introduction of more variables into the manipulation of the dough.

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Proposed Reporting System for Standard Baking Test

By M. J. Blish, Chairman, Baking Test Committee

General Considerations

The need for an adequate standard reporting system for use in conection with the proposed standard baking procedure (1928) is obvious. During the last few months the committee has devoted attention to this important phase of laboratory test baking, and altho no system has been perfected in all details, certain principles have been agreed upon.

Among the loaf properties which are ordinarily regarded as manifestations of flour characteristics are:

1. Volume
2. Crust color
3. External characteristics aside from color
4. Texture or grain
5. Crumb color
6. "Body" of crumb
7. Flavor

In selecting an appropriate standard system for reporting these items, three chief requirements are to be considered: (1) The system must be simple. (2) It must be impartial. (3) It must present in sufficient detail a picture of loaf characteristics (enumerated above) which are to constitute the basis for judging the character of the flour in question.

The need for simplicity requires no elaboration or discussion.

To say that the system must be impartial implies that all matters of personal preference are to be eliminated, so far as the actual standard report is concerned. As the test itself is designed to indicate flour characteristics independent of individual inclinations, the method of reporting must harmonize with the test. This will rule out, for instance, the rating of texture on a numerical basis, and will prohibit the use of such terms as "excellent," "good," "poor," etc. Matters of personal preference may be stated *as such,* but they must be regarded as items outside of the standard report.

The statement that the report must present a complete picture of characteristics means, obviously, that it must include all the various distinguishing features, both external and internal, wherein one experimental loaf may differ from another.

In order to meet the three requirements thus briefly outlined, certain arbitrary units of measurement or points of reference must be agreed upon for all items except volume, which may be reported in cubic centimeters.

External Characteristics Aside from Color

An appropriate standard method for reporting external loaf characteristics aside from crust color will necessarily involve the arbitrary selection and adoption of a standard series of models or photographs indicating the various outstanding and representative types of external visible loaf properties, excluding color. It may be assumed that each technologist will ultimately acquire a standard set of these models or photographs from a common source. The technologist's report dealing with this item will then consist merely of indicating a resemblance to one of the standard types, which may be designated by letter or number. The *degree* of resemblance may be expressed in few and simple terms.

As an illustration of this principle, sufficient for present purposes, six representative types have been tentatively selected, as shown in the accompanying photographs, and each type is represented by letter. However, if one undertakes a verbal description of each type, descriptive terms must be selected and defined in such a way that they will permit of common use and interpreta-

tion. In the case of external loaf characteristics, the committee tentatively suggests the use of certain descriptive terms, with definitions, as follows:

The BASE of the loaf is that portion which has been in contact with the pan.

The DEVELOPMENT is that portion above the pan and due ordinarily to oven spring.

The term SMOOTH has reference to continuity of surface, on either the base or the development.

ROUGH indicates that the surface lacks continuity, either on base or development, or both.

RAW means irregularities which show no tendency to heal by fill-in, and rawness may manifest itself in either ragged or smooth form.

SHELLING, or SHELL-TOP, is that character which manifests itself in a pronounced separation of the top crust from the remainder of the development.

The DEVELOPMENT of the loaf is subject to wider, or, at any rate, more conspicuous variations than is the base. The manifestations of these variations group themselves first into two main classes, smooth and rough. In each of these main classes there are sub-classes or types. Thus in the class designated as "smooth," at least four types may be distinguished as follows:

a. Smooth and symmetrical
b. Smooth and lacking symmetry
c. Smooth with smooth fill-in
d. Smooth with shredded fill-in

There are also the following, and probably more, "types" of rough development:

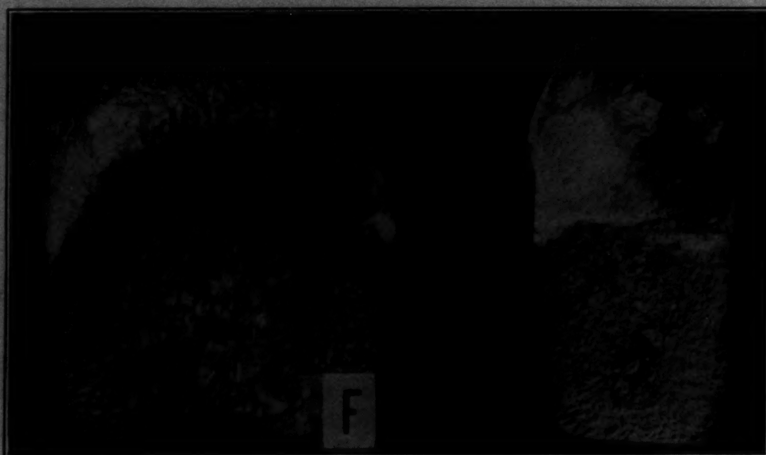
a. Symmetrical irregularity
b. Unsymmetrical irregularity
c. Rawness, i.e., break which did not heal or fill in
d. Rawness may be ragged or smooth
e. Shell-top

The foregoing terms are not to be regarded as absolute or sharply defined. In a description of loaf characteristics, therefore, these terms should be used chiefly as qualifying terms when reporting the resemblance of the loaf to one of the six representative types.

The six types that are herewith tentatively suggested are lettered respectively F, G, H, I, J, and K. These types may be described, respectively, as follows:

Type F. Decided tendency toward bold, smooth, unbroken development. Pronounced break, with smooth, shredded fill-in.

Type G. Tendency toward rough development. Pronounced break, with inclination toward ragged fill-in, but with no appreciable rawness or shell-top.



Type H. Tendency toward break with rough, raw features. Decided inclination toward shell-top.

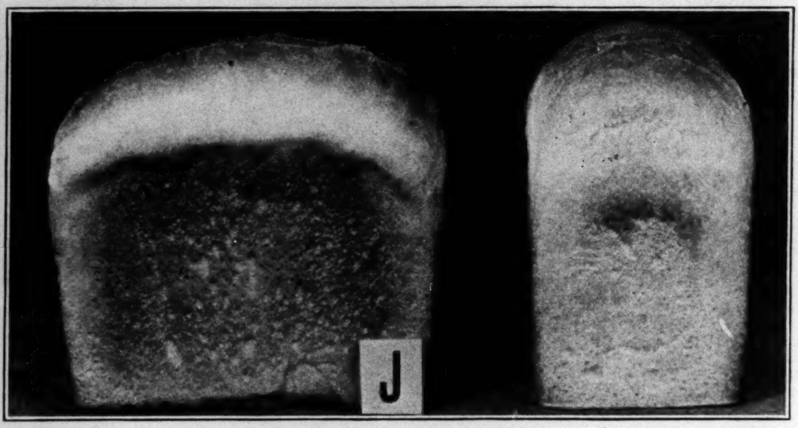
Type I. Tendency toward roughness and rawness in both base and development. Raw and ragged break, if any.

Type J. No appreciable break, but with tendency toward bold, smooth, rounded development.

Type K. No pronounced break or oven spring, but with tendency toward weak, flat, or "mushroom" top.

Under a system of this type, as previously stated, the technologist, in reporting upon external loaf characteristics, will merely indicate the particular type to which the experimental loaf bears the greatest resemblance, mentioning also the *degree* of resemblance.

If the loaf shows certain combined features of more than one of the "standard types," he may so indicate. When necessary, he may also use certain of the proposed "standard" and previously defined terms to qualify his report upon external loaf characteristics. Thus a definite picture may be reported in few and simple terms of common understanding.

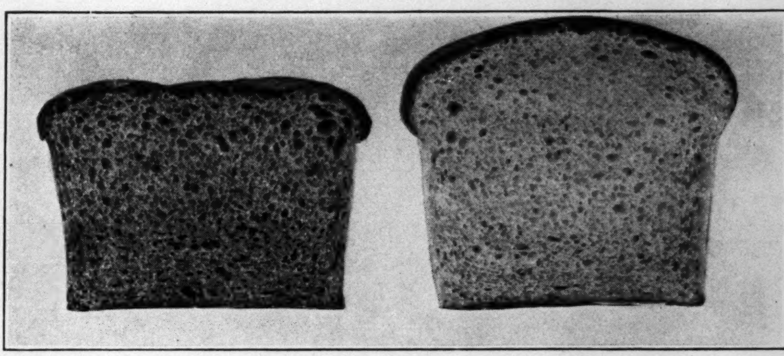


It is to be understood that the photographs and definitions accompanying this report are intended merely to illustrate principles, and are not necessarily those which may be finally adopted as the standard representative types.

Internal Characteristics of Test Loaves, Texture and Grain

C. B. Morison, R. M. Bohn and W. Siedhof co-operating

On May 24, 25, and 26, baking tests (24 bakes) were made by W. Siedhof for the purpose of obtaining data on internal characteristics of test loaves, texture, and grain.



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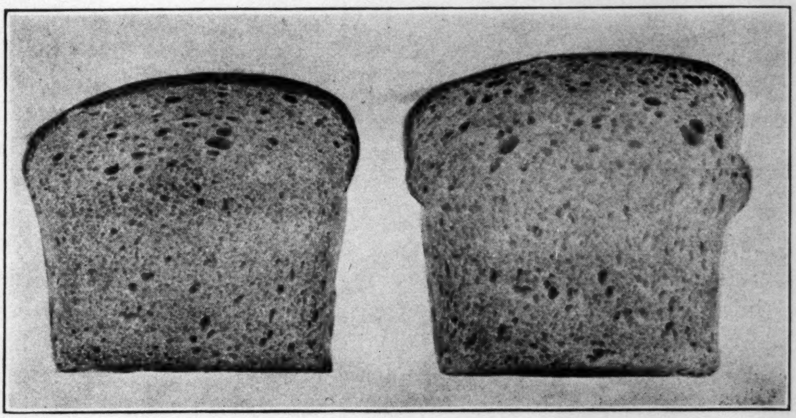

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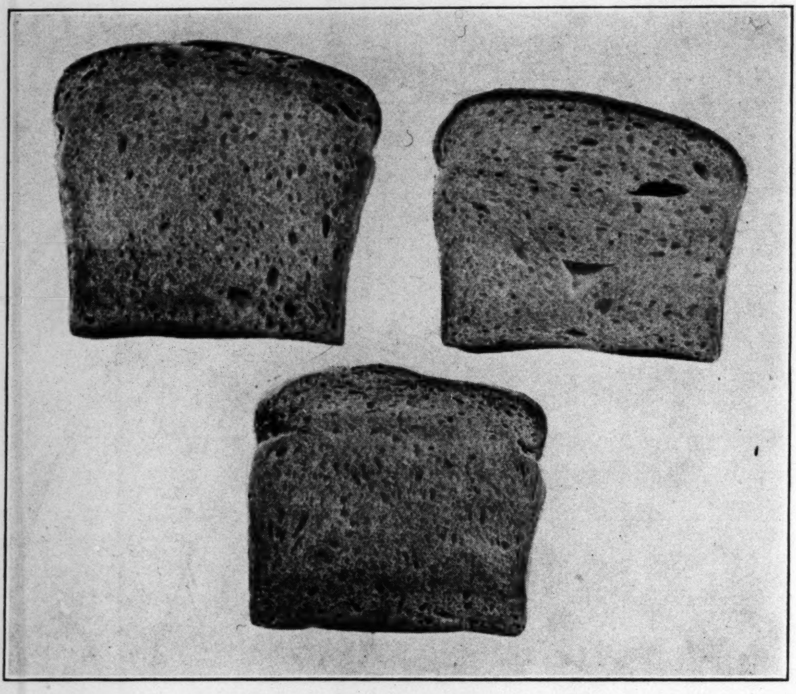
It was the aim of the sub-committee to select various types of flour and bake them alone and blended in order to obtain typical well defined characteristics of grain and texture.

The test loaves were cut and examined by the sub-committee and seven loaves were selected which, in their opinion, were typical of different internal characteristics exhibited by various types of flour alone and blended under the conditions of the baking test.

Photographs were made of the cut surface of each loaf, and also ink-pad impressions for record.

The photographs and ink-pad impressions are submitted to the Baking Test committee for criticism and discussion.



5 7 6

It is well recognized that grain and texture cannot be described in terms that have the same meaning to every one. Photographs and ink-pad impressions are of great value for reference and comparison in the reporting of internal loaf characteristics. The photographs are available at cost to all members interested.

Possible Causes For Variation in Collaborative Reports

By C. G. Harrel

On January 27, 1927, the committee on the Standard Experimental Baking Test met at the University of Nebraska and conducted an investigation regarding the degree to which different operators can duplicate results, under identical conditions. These conditions were attained by assembling all operators in a labora-

tory where the ingredients and equipment used were the same. Errors resulting from variations in temperature, humidity, etc., were reduced to a minimum.

Results from these test bakes were very concordant. The uniformity of the results is emphasized in the report of the committee, Cereal Chemistry, Volume IV, No. 4, pages 299 to 310.

During the last convention year several flours have been sent to a dozen or more collaborators for test baking in their respective laboratories. Each operator was supplied with instructions as far as completed and made available to the writer at the time. The instructions included details regarding formula, absorption, mixing method, fermentation, and other items.

As compared with results from bakes conducted at the University of Nebraska, the reports showed serious discrepancies. In some cases the loaf volume varied by as much as 50 per cent of the average. The operators were totally unable to agree as to the characteristics or respective values of the flours.

Some factors which may account for these much greater discrepancies are:

First. Yeast characteristics. Table I gives the results from tests conducted by the writer when three different yeasts were used.

TABLE I

	Fermentation period	Loaf volume	Score
Yeast	hr.	cc.	
1	3	462	Good
1	3½	472	Good
1	4	476	Good—
1	4½	481	Good—
2	3	410	Good—
2	3½	426	Good—
2	4	452	Good
2	4½	510	Good
3	3	485	Good
3	3½	480	Good
3	4	475	Good—
3	4½	471	Good—

As no uniform system of reporting results has been agreed upon, only an indication of the score has been given. Supplement "B" of the Standard Baking Procedure was used. These data clearly indicate the difference that might occur by the use of different yeasts. They suggest that additional work and specifications are necessary to obtain better agreement.

Second. The importance of conducting a sufficient number of duplicate tests to eliminate unaccountable errors that frequently occur must be stressed.

Assuming a constant yeast supply, Supplement "B" of the Standard Experimental Baking Test was used in conducting a bake series. In Table II are given the data.

TABLE II

Fermentation period	Average volume of duplicate loaves
hr.	cc.
3	419.5
3½	390
4	438
4½	448

The volume of the loaves is emphasized as a means of ascertaining errors. From evidence based on approximately 1000 quadruplicate series involving a larger loaf, it is found that the time-volume curve thus obtained is a smooth curve. Usually any individual points do not deviate more than 2% of the loaf volume from the curve. But it is thus evident that where the average volume of the duplicate loaves on any fermentation period lies off this curve, it is incorrect and should be discarded. Should the volume of one of the duplicate loaves have fallen on the curve, it could readily be accepted.

Where a uniform supply of yeast is not available, it is exceedingly desirable that duplicate tests be conducted on several occasions and by use of data so obtained the average volume and baking results be determined. The importance of running duplicates on the most complicated tests conducted in the laboratory cannot be overemphasized.

Third. The proof period of the standard baking test is set at a definite time interval of 55 minutes. It is a recognized and easily demonstrable fact that increments in proof time have far greater effect on bread characteristics than have similar increments in the fermentation period prior to panning. In other words, the degree of proof greatly determines the bread characteristics. Since yeast is not a stable product, it is suggested that some additional indication of the degree of proof be recorded. It would be highly desirable if the actual volume of the dough at the expiration of the 55-minute interval could be determined. This has two distinct advantages.

(1) The comparison of such volumes gives an indication of the uniformity of the yeast supply when the experiments are conducted on the same flour as is the case in collaborative work involving different laboratories. If the yeast supply is known to be uniform it may serve to detect improper manipulation of the dough in the panning operation.

(2) Since the loaf volume is measured, loaf volume minus dough volume would give a numerical figure for oven spring.

As no quick method for the measurement of dough volume exists, it is believed that the height to which the dough rises in the pan should be recorded. Every baker in commercial work judges the proof by this simple method.

Soft Wheat Flours

By L. D. Whiting

The tentative method approved by the Committee on Standardization of the Experimental Baking Test (March, 1928) and proposed as a standard laboratory baking procedure has been discussed principally in connection with its use as a baking test for hard wheat flours. The application of the test to other classes of flours has been studied to some extent, but the attention of the committee has been directed first toward securing agreement on a tentative procedure for hard wheats. When such an agreement had been reached, it was planned to attack the question of whether the same procedure could be used for other classes of wheats.

The purpose of this report is to discuss briefly the application of the proposed baking procedure to soft wheat flours.

Two main points were investigated in this connection, namely: absorption and fermentation.

Variations in absorption come under the additional and supplementary procedure A. Variations in fermentation time come under additional and supplementary procedure B. However, a majority of soft wheat flours cannot be baked at the absorption of 58% which is prescribed in the basic procedure. It may therefore be necessary to develop a separate basic procedure for soft wheats.

Absorption

To determine the absorption at which soft wheat flours could be satisfactorily baked, 27 soft wheat flours were baked at suitable

absorptions. These are shown in the table. The range of absorption calculated to a 15% moisture basis, was from 51.6 to 58.7 and the average was 53.6%. It is possible that some of these soft wheat flours could have been baked at higher absorptions than were used, but it is not likely that good loaves would have been obtained at an average absorption as high as 58%.

Fermentation

Bakes were made with varying fermentation periods. Fourteen of the flours mentioned were given a two-hour fermentation period as well as a three-hour fermentation period. As shown in the table, the average volume of the two-hour loaves was 484 cc. and of the three-hour loaves, 474 cc.—a slight average increase in volume in favor of the two-hour period. Nine loaves gave an increased volume when fermented two hours in comparison to the regular three-hour fermentation, and five loaves gave a decreased volume.

Some of the loaves from the three-hour fermentation, on the whole, showed signs of exhaustion, pale crust color, and limited oven spring. The loaves from the two-hour fermentation period showed good crust color and good oven spring.

Some work has also been done on the percentage of sugar in the formula for soft wheats.

Further work is being done, but at present it appears that if a basic procedure applicable to soft wheats is to be developed, the absorption should be decreased, the fermentation period shortened, and possibly the percentage of sugar slightly increased.

	On 15% moisture basis		2-Hour fermentation			3-Hour fermentation	
	Protein	Ash	Absorption	Volume	Interior characteristics	Volume	Interior characteristics
1	7.10	0.331	53.5	508	Excellent	444	Good
2	8.28	.355	51.6	518	Very good	573	Excellent
3	7.93	.333	52.9	462	Good	490	"
4	7.96	.534 Phos.	52.9	518	Excellent	509	Very good
5	8.82	.510	53.8	518	Good	499	Good
6	7.74	.529	53.6	444	Fair	416	Fair
7	8.06	.799 Phos.	55.8	528	Good	453	"
8	7.66	.344	54.8	462	"	499	Good
9	8.07	.679 Phos.	54.8	453	Very good	471	"
10	8.66	.385	56.7	490	" "	462	Very good
11	7.51	0.331	52.9	500	Excellent	453	Good
12	8.21	1.03 Phos.	58.7	416	Poor	444	Poor
13	7.77	0.374	54.8	490	Good	462	Fair
14	7.77	0.375	54.8	481	"	471	Good
Averages				6,788		6,646	
				484		474	

Three additional flours were baked at 53.8% absorption.
Five additional flours were baked at 52.9% absorption.
Five additional flours were baked at 52.0% absorption.

REPORT OF COMMITTEE ON METHODS OF TESTING CAKE AND BISCUIT FLOURS

By Mary M. Brooke, Chairman

Chicago, Illinois

(Read at the Convention June 5, 1928)

A committee for the study of methods of testing soft wheat flours was suggested at the meeting, in June, 1927, in Omaha. A resolution to that effect was adopted and the president appointed the chairman, the rest of the committee to be appointed later and the official title chosen.

Soon after, the title of "Committee on Methods of Testing Cake and Biscuit Flours" was chosen as official. The members of the committee appointed to work with Mrs. Brooke were: W. H. Strowd, A. A. Schaal, V. E. Fisher, James M. Gillet, and A. W. Meyer. These appointments were very enthusiastically accepted.

A letter was written to all members of the committee outlining some of the ideas we hoped to carry out throughout the year. When I first tried to find a point of initial attack on the problem, I realized that so little work had been done and none of it concerted that about all the committee could do was to gather together information from any and every source and get ideas in this way.

The first letter embodied this idea, with a promise that in about two months a questionnaire would be sent to the committee to tabulate and classify this information. It was also suggested that after the first questionnaire was sent to the committee one should be sent to anyone whom the committee named as interested. In this way we hoped to get the necessary information upon which to base future work.

The first questionnaire was sent to the committee in November, with a 100% response and with lists of others to whom the same questionnaire was sent. More than a hundred copies were sent out and the response was excellent.

The following is a resumé of the answers to this questionnaire. While it is detailed and may seem rudimentary, it gives an excellent picture of the ideas of interested persons and the work that is obviously necessary. The answers to twenty-nine questionnaires are tabulated.

1. What chemical determinations do you make on soft wheat flour?

(a) If you make protein determinations, what do they tell you and what method is used?

This determination used as routine by 23; one made it occasionally, and 5 washed gluten. Most of those making the determination used the modified Kjeldahl-Gunning method with copper sulphate and sodium or potassium sulphate. The others used mercury oxide. All agreed that while indicative of quantity, it told nothing of quality of protein. The few who washed gluten did so as a test of quality more than of quantity.

(b) Ash determination?

Ash determination made by 24. All agree that it is indicative of grade of flour—nothing more. The A. A. C. C. method was used.

(c) Acidity determination?

Used as routine by 7, used occasionally by 9, not used by 3. Value is doubtful. Those using it think it is an indication of rancidity, over-bleach, or spoiled wheat. Official method was used.

(d) Gliadin determination?

Not used by any.

(e) Viscosity determination?

Used as routine by 5, used occasionally by 3, not used by 10. Its value is doubtful. Those using it are for it, some think that it gives more information with soft wheat flour than with hard wheat flour. Some were certain that it gives no information. The others are doubtful. Various methods were used.

(f) Hydrogen-ion determination?

Used as routine by 4, used occasionally by 5, not used by 11. The answer as to its value is the same as for viscosity. Titrometer and electrolytic methods were used.

(g) If any other tests are made, give results and methods.

Moisture test reported by 6 and it is assumed that all use this test who make chemical determinations. Vacuum and air ovens are used.

Kreis rancidity test reported by one.

Granulation test, sieve method, reported by one.

Microscopic examination reported by one.

Pekar color test reported by one.

2. What type or types of baking tests do you make?
   (a) If bread baking test is used, give methods and what results you think you obtain. Can you interpret this test to different uses of soft wheat flour? What method of scoring do you use? Please answer in detail.

   Bread baking test used by 11 for various reasons—because they think it is more exact, because they were more familiar with it, and because the bread baking test is more standardized. No one believed he could make a satisfactory interpretation. Methods of scoring varied, but usually none were used.

   (b) If cake baking test is used, give method and what results you think you obtain. Can you interpret this test to different uses of soft wheat flour to various types of cake? What method of scoring do you use? Please answer in detail.

   Cake baking test used by 13, the largest per cent using a white shortening cake, a few, yellow cake, some, angel cake; a few using two or all three types. According to the methods sent in, no two were using the same formula or procedure, altho some of the white cake formulas and methods were fundamentally the same. Some method of scoring was used in most cases, in all such, one of personal invention. No one seemed to think that his test was all-satisfying, but all would like to have a cake baking test that is. None seemed to think that they could interpret this test to other uses of soft wheat.

   (c) If biscuit baking test is used, give method and what results you think you obtain from this test, etc.

   Biscuit baking test used by 12. In every case flour was being sold or tested for making biscuit, usually a self-rising flour. Formulas varied somewhat but were fundamentally the same. All agreed that it could not be interpreted for other uses. Types of scoring in this test were more definite than in any other. One operator sent in a very comprehensive score card. This type of baking test seems to be much more standardized and satisfactory for its particular use than any other considered.

   (d) Cracker baking test.

   This test used by 2, one as a direct test for making crackers and one as a general test for quality of soft wheat flours. Neither gave much information as to the interpretation of results. In the latter case, it was in the experimental stage.

(e) A cookie baking test was reported by one as a test for general quality, but he was doubtful as to its interpretation.

No baking tests were used by 4.

3. Do you use one, or a combination of more than one test to tell the different characteristics of the flour? Are you satisfied with this information?

All say that a combination of chemical determinations or chemical and baking are necessary. This follows exactly the trend of the bread flours. A few were fairly well satisfied with results from their own standpoint, but do not feel that they may interpret the result for others or for other uses. More were dissatisfied and were looking for something better and more standardized.

4. Do you find many soft wheat mills chemically controlled?

The vote was 7 yes and 16 no.

5. Do you find many millers who know just what type of flour is best suited for the particular method for which it is to be used? If not, do you think this is the fault of the miller, or the fault of the baker in not knowing what is best?

Four answered yes, 17 answered no, one blamed the miller, 3 blamed the baker, and 12 blamed both. It is obvious from the answers that the work of this committee will have to be rudimentary until we get a basis of classification. The answers to this question, above all others, show the need of standardized methods for, I believe, until we get them the baker and the miller can never get together and solve their problem.

6. Do you feel that grading soft wheats as hard wheats are graded, on type and protein content, for buying and selling would help this situation?

The vote was 13 yes and 9 no, the 13 thinking that we would have less confusion and the 9 that we would have more.

This ends the summary of the questionnaire.

On January 23 the committee met at the Hotel Sherman, Chicago, to consider the results of what had been done and plan action for the rest of the year. Responses had been so prompt, so much interest had been shown in the work, that we felt much gratified. All committee members were present except Mr. Schaal, and, by invitation, Mr. Whiting was present.

The committee summarized the questionnaires and drew conclusions as follows:

1. Practically all laboratories are making the usual routine chemical determinations of protein, ash, moisture, and occasionally acidity. The methods as adopted by this association are usually followed. We believe this committee need do no further work or make any recommendations on these.
2. Opinion is divided as to the worth of the viscosity and hydrogen-ion determinations and some opinions are quite decidedly pro and con. The committee recommends further study of these two determinations. At present we think that other problems are more opportune and necessary.
3. That a baking test of some type to be used in conjunction with the routine chemical tests was the most necessary and opportune problem before us. We had too little time to take up more than one type of test. After carefully going over the opinions we decided that the majority wished a cake baking test. The users and millers of biscuit flour had at least a basis and were fairly well satisfied with their tests, the cracker and cookie bakers being in a minority. As the majority of cake baking tests now in use were white shortening cakes, this was chosen as a basis.

The committee then recommended that formulas and methods of procedure be chosen by the chairman; that flour samples for the test be sent out by Mr. Strowd; that other ingredients be sent out by members of the committee, and that these be used in a collaborative baking test problem. The collaborators were members of the committee; the American Institute of Baking, represented by Dr. Morison; Mr. Glabau, of Bakers Weekly; Mr. Whiting, of Ballard & Ballard; and Mr. Libby, of the Mennel Milling Company. This constituted a group of ten representing millers, bakers, manufacturers of leavening agents, and a commercial laboratory.

4. We wished to know whether or not our test might be useful in working out problems other than characteristics of the flour. The committee recommended a problem to be instituted in this collaborative work and instructed Dr. Strowd to obtain flours of different granulation as two of his samples.
5. It was recommended that ingredients such as powdered milk rather than fresh milk, egg albumen rather than fresh eggs, be obtained for making the test. These ingredients could be standardized.

Dr. Strowd obtained six samples of flour; (1) soft wheat clear, (2) soft wheat straight, (3) special cake flour, (4) soft wheat patent, (5) flour through a 9xxx and over a 14xxx cloth, and (6) a flour through a 14xxx cloth. These were sent to the collaborators. A supply

of powdered milk, powdered egg albumen, and baking powder was obtained and likewise sent to the collaborators.

From the questionnaires three different formulas were chosen and two methods of procedure. These were all being used as baking tests in laboratories of persons answering the questionnaires. The following are the formulas and directions:

First Letter

	Number 1 gm.	Number 2 gm.	Number 3 gm.
Flour	225	160	200
Sugar	173	100	150
Hydrogenated shortening	75	75	100
Water	250	190	190
Powd. milk	15	18	13
Egg albumen	5	18	5
Salt	5		5
Baking powder	11 ½	11½	10

Two methods of procedure may be followed and I would like you to try the two against each other. These two methods will apply to all three formulas.

The first method is to sift together all dry ingredients—flour, salt, powdered milk, egg albumen, and baking powder. Sugar and shortening are first creamed together for a definite length of time, about twelve minutes. This you can best determine for yourself as a matter of criticism to the method. Then water and dry ingredients are added alternately. After adding all the ingredients, the mass is beaten for two minutes.

The second method is to dissolve the egg albumen in approximately one-third of the water, and the powdered milk in the rest. Then cream approximately half of the sugar with the shortening, as above; beat the other half of the sugar with the egg white in a separate bowl. The beaten egg whites are then added to the creamed sugar and shortening and mixed for just an instant. Then the flour, into which has been sifted the baking powder, is added alternately.

Comments

Formula 1 is very severe on the flour, as it receives little assistance from the egg and the milk. Formula 2 is much easier on the flour, as it is greatly assisted by the amount of albumen and milk. The third test is designed to fall between these two.

Of the two methods of procedure, the second will give the best cake, but I believe the first will be less liable to error, as there are not so many parts to the operation and not so many places where the time factor may go wrong. None of these formulas are original; they were all taken from questionnaires sent out from laboratories that are making baking tests. Formula 1 was published in Cereal Chemistry.

We may get good results from one of these tests, we may get poor results from all, but by trying them we can find where our faults lie and what obstacles must be overcome.

Second Letter

A portion of baking powder to be used in the collaborative work on cake baking tests was mailed to you yesterday. This will give you all the supplies necessary for this work.

The question has been asked as to which tests were to be given preference in case the samples were too small to make all tests asked for, the samples sent being only two pounds. Have put the formulas in the order in which I would like the work to be done, in other words, use Formulas 1 and 2, and use Formula 3 only if you have enough material, which I hope you will have. Use method 1 first, and method 2 only if you have sufficient samples. If you have not enough of the samples sent by Dr. Strowd, you might try three formulas and two methods on samples that you have, and make a general report on the methods.

What size of pan to use has also been asked. I thought about sending out pans, but decided this would be hard to do and do not believe it will be necessary in order to get comparative results. However, my advice is to use a pan of approximately the following dimensions: 3 x 6¾ inches bottom measurement, 3½ x 7½ inches top measurement, and 2¼ inches deep. This pan contains about 52.8 cubic inches. Allow an ounce to every 5 inches of cubic content for the approximate scaling weight, 10½ ounces about the right volume of dough for this pan. The pan should be lined with thin manila paper.

I would not advise buying new pans for this purpose. If you have a pan of approximately the same size, figure the cubic contents and amount of dough in the proportion that has been used for the other pan.

The baking temperature should be about 375 degrees in an electric or gas oven. Time of baking at this temperature will be approximately fifteen minutes.

In sending out these directions, I purposely did not make them detailed, as the work is so new. I thought that would only be imposing personal opinions. The working out of details was left to each individual, and when results came in we had an expression of how they could be worked out.

Following is a resumé of reports from all collaborators:

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Flour	225	Flour	160	Flour	200
Sugar	173	Sugar	100	Sugar	150
Hydrogenated shortening	75	Hydrogenated shortening	75	Hydrogenated shortening	100
Water	250	Water	190	Water	190
Powd. milk	15	Powd. milk	18	Powd. milk	13
Egg albumen	5	Egg albumen	18	Egg albumen	5
Salt	5	Salt		Salt	5
Baking powder	11 ½	Baking powder	11½	Baking powder	10

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What size of pan to use has also been asked. I thought about sending out pans, but decided this would be hard to do and do not believe it will be necessary in order to get comparative results. However, my advice is to use a pan of approximately the following dimensions: 3 x 6¾ inches bottom measurement, 3½ x 7½ inches top measurement, and 2¼ inches deep. This pan contains about 52.8 cubic inches. Allow an ounce to every 5 inches of cubic content for the approximate scaling weight, 10½ ounces about the right volume of dough for this pan. The pan should be lined with thin manila paper.

I would not advise buying new pans for this purpose. If you have a pan of approximately the same size, figure the cubic contents and amount of dough in the proportion that has been used for the other pan.

The baking temperature should be about 375 degrees in an electric or gas oven. Time of baking at this temperature will be approximately fifteen minutes.

In sending out these directions, I purposely did not make them detailed, as the work is so new. I thought that would only be imposing personal opinions. The working out of details was left to each individual, and when results came in we had an expression of how they could be worked out.

Following is a resumé of reports from all collaborators:

1. Four collaborators were in favor of formula 1 and method 1; Two, formula 2 and method 1; Two, formula 1 modified, one cutting the amount of egg albumen and one the salt content. Two made no recommendations.
2. Results were surprisingly consistent for the first attempt in judging the quality of the flour.

Relative Position of Each Flour

Collaborator	Flour No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
1	6	3	1	2	4	5
2	6	.	1	.	.	5
3	5	3	1	2	4	6
4	4	3	1	2	6	5
5	5	2	1	3	4	6
6	5	3	1	2	4	6
7	5	3	1	2	4	6
8	*	3	1	2	*	*
9	4	3	1	2	5	6
10	6	3	1	2	5	4

*Rejected.

3. Criticisms of collaborators:
   (a) Those recommending formula 1 did so because it brought out differences in cake and hence differences in characteristics of flour. Those recommending formula 2 did so because it makes the best cake.
   (b) Method 1 was unanimously chosen because it is less liable to be affected by the personal equation and consequent errors of determination.
   (c) Uniform type of equipment must be considered. The hearth of the oven plays a much more important part in cake baking than in bread baking. Temperature is to be constant.
   (d) Time of creaming of sugar and shortening shall be specified.
   (e) Temperature of creaming of sugar and shortening shall be specified.
   (f) Uniform pan dimensions shall be specified, altho collaborators were of divergent opinions as to what those dimensions should be.
   (g) A uniform method of scoring should in time be adopted, but most collaborators feel that this will come after the method has been more clearly worked out.
   (h) Type of mixing is important for uniform results, whether mechanical or by hand, altho I was surprised to find that, in comparative analysis, this played so small a part.

(i) Some type of uniform volume apparatus should be adopted. This will depend on size and shape of the pan.

(j) Time of baking will depend on size of pan and temperature, but must be determined, as must be the temperature.

4. Recommendations of collaborators:

(a) That we determine and recommend such factors as are offered in the criticisms.

(b) That another test be made, with flours of less divergent analytical factors and characteristics.

(c) That all formulas and methods be run on one flour.

The committee met yesterday afternoon, the report was read, and after consideration of the results the following recommendations were made:

1. That further collaborative cake baking tests be made. Other baking tests were considered, but it was decided to continue along the same line. This will give us enough work for the time being.
2. That method 1, as used in the first collaborative test, be used in all future work.
3. That formula 1 be modified to read as follows:

	gm.
Flour	225—amount to calculate on 15% moisture basis
Sugar	175
Hydrogenated shortening	75
Water	250
Powdered milk	15
Egg albumen	5
Salt	3
Cream of tartar	6
Soda	3

To be used as a basis of collaborative work.

4. That another collaborative test be made with three flours, using first the standard formulas and then modifications—such modifications and directions to be chosen by the chairman.
5. That methods of procedure, size of pan, time of creaming, temperature of creaming, and all other necessary specifications be given by the chairman.

ADDRESS OF THE PRESIDENT

LESLIE R. OLSEN
Minneapolis, Minnesota

(Read at the Convention June 4, 1928)

We are assembled in the fourteenth annual convention of this association. Twelve months have slipped by since last we gathered to renew friendships, discuss our problems, and learn of new developments in our chosen field of work. The News Letters have brought to you the important happenings in our association life. Further activities will be revealed as the officers and committees make their reports during this convention. On the whole, we have continued to prosper during the year. Your vice-president, secretary, and other officers have worked together with faith in one another. It is pleasant to close the year with such memories, and I wish in this inadequate way to express my sincere appreciation of the support of the association members and the earnest work of the officers and committees.

Our secretary informs me that while 46 chemists have joined our ranks during the last year, we have lost the same number, for various reasons, mainly the increase in dues. Our total membership, therefore, is no more than a year ago, but our revenue has increased $680. True, we should not estimate our success in terms of dollars; nevertheless, I do not believe that the association will suffer any from the loss of members who may have dropped out on account of the increase in dues. Most of them were not taking an active part in association affairs. Numbers mean nothing unless each member is working for the good of all. However, we should constantly strive to increase our membership. We can reach the 500 mark if every one of you will make an effort to bring in a new member. There is undoubtedly a worth-while cereal chemist among your acquaintances who may simply be waiting for an invitation to join. The secretary will gladly write to any prospect if you will send in his name and address.

The additional money made available through the increase in dues has permitted somewhat greater activity than formerly. Four full-sized News Letters were issued during the year. We were able to send the chairman of the baking committee to Chicago in March for an important meeting. The cost of designing and making the Osborne gold medal exceeded the sum of money turned

over by the Omaha convention committee for that purpose, and the additional cost was paid out of the treasury. At no time, however, during the year have we had any difficulty in meeting the running expenses of the association.

The Book of Methods project has been completed and is a monument to the ability of Dr. Coleman and his committee. The hard work of this committee will be more and more appreciated as time proves the value of the book. As Rowland Clark so well stated in the introduction: "The gratitude of this Association is whole heartedly extended to Dr. D. A. Coleman, who, through his untiring efforts as Chairman of the Committee on Methods of Analysis for three years, has brought this collection of procedures to its present form." The rapid disposition of the 500 copies was in the hands of our capable secretary and was made possible largely through advance subscriptions of members and generous response on the part of non-members. Only a few copies remain unsold, and the first edition will soon be exhausted. The book has been well received and the editor of one of the leading milling journals, in reviewing it, stated that he did not see how any mill laboratory could get along without it. Neither do we.

Two years ago, at Denver, it was decided to award a gold medal for distinguished service in the field of cereal chemistry. A jury of awards was later appointed, with Dr. C. L. Alsberg as chairman. At the Omaha convention it was announced that the medal would be named in honor of Thomas Burr Osborne and that he was to be the first recipient. The Osborne gold medal is now a reality and will be presented during this convention. The design was worked out by Dr. Alsberg and the medal was made, under his direction, by Shreve & Company, of San Francisco. The dies are the property of the association, but for the present are being kept in the jeweler's vault. When occasion arises to make another medal award, the association can either place the order for the medal with Shreve & Company or some other company. The dies do not bear the name of the person to whom the award is made, nor the date. Blank spaces are provided so that the name and date may be worked on each medal as it is struck off.

A most gratifying development has been the splendid co-operation shown us by the Millers' National Federation. Their recognition of our work for the benefit of the industry is greatly appreciated and their interest in the success of our association is very encouraging. Just a few weeks ago this gathering was made the

subject of one of their bulletins to members and attendance here was urged. Also, application blanks were enclosed to mills whose chemists were not members of our association. We will be privileged to hear H. L. Beecher, chairman of the board, at the joint session with the Association of Operative Millers, on Wednesday. The personal effort that he is making for us is gratefully acknowledged.

Two more sections are in the offing; one at St. Louis and the other at Spokane. As soon as conditions warrant, each intends to apply for a charter. These local sections are vital to the life of the association, and we should encourage the formation of more of them. It seems probable that a section could flourish in Buffalo, and I have been expecting a move of this kind on the part of the members there. We need more complete organization among our sections, and I suggest that the executive committee draw up a set of by-laws to be recommended to the local sections so that each section will function in approximately the same way.

Our journal, Cereal Chemistry, continues to maintain its high place in the field of scientific research. Its circulation is constantly increasing. The editors will welcome more short papers from chemists who are in commercial work. As members of the association, we should not merely absorb the valuable papers in each issue, but should patronize the advertisers when purchasing laboratory equipment. It only takes an extra minute or two to state in your letter that you saw the piece of apparatus described in Cereal Chemistry. It requires money to publish a journal. Advertising materially helps to defray the cost.

For some time it has been felt advisable to make a study of the needs of our constitution. Certain amendments, as they now stand, are ambiguous and others are inoperative. Accordingly, the executive committee, under the chairmanship of Mr Mangels, has been giving the matter careful thought and will submit a revised constitution for vote at the business session on Wednesday morning. The revision will incorporate all amendments made to date, and additional changes that appear desirable. I would like to see associate membership abolished. Applicants who are not eligible for active membership do not add to our prestige as a scientific organization. The few members who are now classified as associate should be made active members.

During the convention at Omaha, I requested each of the past-presidents to furnish me with a synopsis of their administration, at

some time before we met again. Not all past-presidents have submitted a story covering the high-lights of their term of office, but I have their promise to do so. From about a dozen members, our organization has grown until now we have nearly 400, scattered over many countries. What is responsible for this growth? The stories furnished by our past-presidents, when put together, will give the answer and will form an interesting and valuable history of the association for the benefit of its future officers and members.

During the last year the milling industry lost through death an outstanding chemist, Harry Snyder. He was regarded as probably the foremost American authority in the field of the industrial chemistry of cereals. His friends, both in this association and elsewhere, will long remember his kindly, modest disposition, his simplicity of manner, and the spirit of helpfulness that he extended to every one. Professor Snyder was always an indignant and forceful objector to the cult of food faddists that defame white bread. He had investigated the nutritional qualities of bread made from white flour and was confident of his findings, which were that the white loaf was incapable of harming the human system, and was, on the contrary, man's "best and cheapest food."

Another answer to the insidious propaganda against white flour is the book entitled, "Wheat Flour and Human Food," written by C. O. Swanson, head of the milling department of the Kansas State Agricultural College, which will soon be off the press. According to Dr. Swanson, the purpose of his book is to tell briefly and clearly the story of wheat flour, whose good name we are interested in maintaining. We should all know and understand the important place it occupies in human nutrition. If this is clear to us, we can tell it to others.

In the last News Letter I predicted that this convention would be unparalleled in its success, and now that you are here, I am sure that you believe it yourselves. A great deal of credit belongs to Mr. Gray and his local arrangements committee, who have labored hard for your benefit. Their burden has not been light, as you can readily appreciate if you have ever been a member of a local committee when the convention came to your city.

In conclusion, I wish to present to this convention for its consideration the following recommendations:

1. That the association co-operate still more closely with the National Federation and stand ready to work on any technical problems that may confront them.

2. That the executive committee draw up a set of by-laws to be recommended to the local sections so that each section will function in approximately the same way.

3. That associate membership be abolished, and that any members who are now in that classification be automatically made active members.

4. That a committee be appointed to prepare a history of the association and arrange for publishing it in booklet form.

5. That a memorial resolution be spread upon the secretary's minutes commemorating the work of Harry Snyder, who died October 11, 1927.

6. That as the attack upon white bread is not justified, our publicity committee be given the special responsibility of combating any propaganda intended to defame white flour.

MINUTES OF FOURTEENTH ANNUAL CONVENTION OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

By M. D. Mize, Secretary-Treasurer

Nicollet Hotel, Minneapolis, Minn.

June 4-8, 1928

Monday, June 4

Convention called to order at 10:15 a. m. by President L. R. Olsen

Invocation by the Reverend Dr. H. P. Dewey, pastor, Plymouth Congregational Church

President's address, by L. R. Olsen

President Olsen extended sincere thanks on behalf of the association to the chairmen of various committees who have served during the last year

M. A. Gray, chairman of Local Arrangements Committee, introduced the members of his committee

Foreign members and friends of the association who were present were introduced by President Olsen

Reading of communications: Letter expressing good wishes from Henry Stude, President of American Bakers Association; Bulletin No. 621 published by the Millers' National Federation

Appointment of convention committees:

Auditing committee: A. R. Sasse, chairman, A. W. Meyer, C. B. Kress

Resolutions committee: G. L. Alexander, chairman, H. F. Vaupel W. A. Richards

Nominating committee: S. J. Lawellin, chairman, A. W. Alcock, A. A. Jones

M. F. Dillon presented the association with a new gavel of very "honorable" origin

Paper—"Criteria of Validity of Analytical Methods Used by Cereal Chemists," by A. E. Treloar and J. A. Harris

Paper—"The Mechanical Method of Modification of Dough," by C. O. Swanson

Meeting adjourned at 12:10 p. m. for lunch in honor of past presidents

Tuesday, June 5

Meeting called to order at 9:00 a. m. by President Olsen

Discussion of Dr. Swanson's paper

Report of Committee on Standardization of the Experimental Baking Test, by M. J. Blish:

Sub-report by C. H. Bailey, C. C. Fifield, and R. C. Sherwood, "A Comparison of the Proposed A. A. C. C. Baking Test and the Commercial Loaf Test"

Sub-report by M. J. Blish, "Proposed Reporting System for Standard Baking Test"

Sub-report by C. B. Morison, "Internal Characteristics of Test Loaves"

Sub-report by Emily Grewe, "Crust and Crumb Color"

Sub-report by C. G. Harrel, "Possible Causes for Variation in Collaborative Reports"

Sub-report by L. D. Whiting, "Soft Wheat Flours"

Moved by M. J. Blish that the proposed baking method be adopted as a tentative method of the association. Seconded, carried.

Meeting adjourned at 12:10 p. m.

Meeting called to order at 2 p. m. by President Olsen

Report of Committee on Methods of Testing Cake and Biscuit Flour, by Mary M. Brooke, chairman

Moved by R. L. Frye that report be accepted. Seconded, carried.

Report of Committee on Methods of Analysis, by D. A. Coleman, chairman

Moved and seconded that we extend to Dr. Coleman and his committee a rising vote of thanks for the splendid work done during the last year. Carried.

Moved by F. A. Collatz that report be accepted. Seconded, carried.

Paper—"How the Experimental Baking Test Has Developed," by C. L. Brooke and R. C. Sherwood

Paper—"Calibration of Loaf Volume Boxes," by C. G. Harrel

Paper—"A Critical Study of Certain Factors Involved in Evaluating Soft Wheat Flours for Biscuit and Cracker Production," by J. A. Dunn, G. N. Bruce, and A. A. Schaal

Paper—"Granulation of Flour—Relation to Baking Quality," by C. B. Kress

Meeting adjourned at 4:45 p. m.

Wednesday, June 6

Meeting called to order at 9:00 a. m. by President Olsen

Moved and seconded that minutes of previous convention as published in Cereal Chemistry be approved. Carried.

Report of vice-president and chairman of executive committee, C. E. Mangels

Report of Executive Committee

The function of the executive committee is to perform such routine duties as may be assigned and to guide the policy of the association between meetings.

One of the routine duties of the chairman of the committee is the approving of bills and countersigning of checks issued by the secretary-treasurer. During this year more than 75 checks have been countersigned, totaling more than $7500.

The executive committee has also undertaken to revise the constitution of the association, with the intention of improving and clarifying the document.

Last year the financial condition of the association made necessary an increase in annual dues. In spite of this increase, however, we are able to show practically the same membership as last year. Our secretary-treasurer has spent considerable time and effort in rounding up delinquents, and were it not for his splendid efforts, our membership roll would show a decrease.

The association treasury is in better shape than last year, and every member of the association should help to keep it in good condition. We should endeavor to build up a surplus and should add to the reserves each year until the association is on a sound and permanent financial basis. This can be accomplished by increasing our membership and at the same time carefully budgeting our necessary expenses. The work of the secretary-treasurer, however, has greatly increased, and a reasonable increase in the running expense of this office may be expected as the membership and activities of our association increase.

As chairman of the executive committee, I wish to take this opportunity to express my appreciation to the other members for their excellent co-operation in carrying on the work throughout the year.

1. The executive committee approves and indorses the recommendations made by our president, Leslie R. Olsen, in his address.
2. The executive committee approved granting a charter to the St. Louis Cereal Chemists Club as a local section of the American Association of Cereal Chemists.
3. On account of the varied ideas of different governments regarding specifications for soundness in flour, and the consequent effect on export trade, it is recommended that this association appoint a committee to study such specifications and methods of analyses and be prepared to advise the proper agencies and authorities, governmental or otherwise, in respect to such specifications and methods.
4. The executive committee wishes to present the name of Thomas Burr Osborne for honorary membership in this association.
5. The suggestion of J. P. Lewis, of Montana, that the association appoint a committee to study the possibility of standardizing the experimental milling test was discussed in committee. The committee is of the opinion that the appointment of a special committee to standardize experimental milling is not advisable at this time.
6. Invitations for the 1929 convention have been extended by Kansas City, Detroit, Buffalo, San Francisco, Toronto, Memphis, and Philadelphia. The executive committee requests the convention to express a preference.
7. The executive committee is presenting for the approval of the association a revised constitution.

C. E. Mangels, Chairman
M. A. Gray
R. W. Mitchell
H. E. Weaver
Executive Committee

Report of the Secretary-Treasurer of the American Association of Cereal Chemists

By R. K. Durham

June 1, 1928

This is the fifth annual report submitted by the present secretary-treasurer, and it may be interesting to sum up the association's growth in membership. On June 4, 1923, we had 169 members, today we have 355, a gain of 186. This increase, in itself, does not seem very great. On the other hand, almost 300 new members have been elected during the five-year period. Obviously the turnover is great.

No new local section charters have been granted during the year. The four charters granted last year are still in effect. Local sections have been organized in St. Louis and in the Pacific Northwest. These groups will probably apply for charters in the next year.

At Omaha, last year, the local arrangements committee solicited funds that exceeded expenditures by $250.07. This money was turned over to the association and put into the Osborne medal fund. This amount will almost cover the expense of making the die and the first medal. Future medals will cost less as we now have the die, which cost $210.

The association has just published a new Book of Methods. While advance subscriptions fell far short of meeting the expense of printing, it was thought advisable to go on with the publication. About 420 of the 500 copies printed have been sold. Cost of printing, advertising and mailing has been, to date, $1168.64. Income from sale of books totals $1116.87. Accounts receivable amount to $160.50, making the total income $1277.37, which leaves a small balance on hand. Some bills are outstanding against this project, but the surplus, together with the sale of the remaining copies, should easily offset them.

Detailed Membership Statement

	Active and Associate	Corp.	Honorary	Total
Membership, May 28, 1927	310	43	2	355
New members added	42	3	0	45
Members reinstated	1	0	0	1
	353	46	2	401
Resigned and suspended for non-payment of dues	44	2	0	46
Paid up membership, June 1, 1928	309	44	2	355
Gain or loss in fiscal year	—1	+1	0	0

Financial Statement

RECEIPTS			
Cash on hand May 28, 1927		$ 966.84	
Membership dues, Active $2.281, Corporation $470.00		2751.00	
Application fees		63.00	
Cereal Chemistry subs., reprints, back numbers		1720.58	
Advertising		1190.50	
Interest on Building & Loan stock		129.16	
Sale of Building & Loan stock		500.00	
Osborne Medal fund		250.07	
Sale of Book of Methods		1116.87	
Miscellaneous receipts		16.45	
Total receipts			$8704.47
DISBURSEMENTS			
Convention expense		$ 79.77	
Editing, printing & mailing Cereal Chemistry		3748.34	
Reprints		533.48	
Commission on advertising		136.80	
Expense of president's office including News Letters		289.97	
Expense of secretary-treasurer's office		268.29	
Gift to R. J. Clark		25.00	
Gift to R. K. Durham		25.00	
Purchase of Building & Loan stock		3500.00	
Books of Methods		1168.64	
Miscellaneous expense		105.03	
Total disbursements			$7880.37
CASH ON HAND June 1, 1928			824.10
Assets			
Petty cash fund in Minneapolis		$ 100.00	
Cash in bank			
First National Bank	$348.84		
Intercity State Bank	442.75		
			791.60
Cash on hand but not deposited		32.50	
Accounts receivable			
Sale of Book of Methods		160.50	
Building & Loan stock		3500.00	
TOTAL ASSETS			$4584.60
Liabilities*			0.00
Net worth, June 1, 1928			$4584.60

*Undeterminable liabilities include editing Cereal Chemistry for the remainder of the year, Osborne Medal, and Book of Methods.

Moved and seconded that reports of vice-president and secretary-treasurer be accepted. Carried.

Report of committee on allied associations, by H. E. Weaver, who told of the inactivity of this committee.

Moved and seconded that the report be accepted. Carried.

Report of committee on employment, by C. B. Morison that 117 letters were written, 127 names were registered, and 8 positions were obtained for members.

Report of publicity committee, by R. J. Clark, Chairman:

Report of Publicity Committee

By R. J. Clark, Chairman

The activities of the publicity committee during the year just closed have been almost routine. The largest item included was forwarding the News Letters to the various trade publications. Twenty-four magazines are now on the mailing list. There have been four issues of the News Letter—a total of 96 News Letters mailed out as publicity matter.

Watching the trade journals for articles in which the field of cereal chemistry was attacked or misrepresented has occupied considerable time. One article was regarded as so poor in constructive criticism that a reply was prepared.

This watchful waiting policy made it very easy to make clippings whereever reference was found in the press to association activities. These clippings have been brought together in a scrap-book, which may prove of interest to future association historians.

Report of Question Committee

By S. J. Lawellin, Chairman

During the last fiscal year, this committee has received and answered questions from three inquirers. Two of these were very simple. One was compound and required a lengthy answer. This was placed before all members of the committee and a composite answer was returned to the questioner.

Some advertising has been done by personally calling attention to this committee and its work at various meetings of the different organizations of the industry.

The co-operation of the committee members has been highly appreciated.

Report of program committee, by C. H. Bailey, chairman

Report of local committee of convention arrangements, by M. A. Gray, chairman

Report of editor-in-chief of Cereal Chemistry, C. H. Bailey

Report of managing editor, R. C. Sherwood

Report of Managing Editor of Cereal Chemistry

By R. C. Sherwood

In viewing the financial status of the journal as indicated by the treasurer's report, it must be remembered that the journal is now in the middle of its fiscal year. Income for 1928 from membership dues and subscriptions to be used for publishing Volume V is practically all in the hands of the secretary-treasurer, while only one-third of the expense for the year has been paid. The principal source of additional revenue for 1928 is advertising, with a small amount anticipated from new subscriptions and back issues.

Three numbers of Volume V have been issued, but at the close of business May 25, 1928, the third issue was not yet mailed. Therefore about two-thirds of the total expense of printing Volume V is unpaid.

The expenditures for Cereal Chemistry from January 1 to May 25, 1928, were \$1339.91. The estimated expenditures for the rest of the year are \$2741, making the total estimated expenditure for Volume V, \$4080.91. Receipts from January 1 to May 25, 1928, were \$3017.88. Estimated income for the rest of the year is \$900, giving the total estimated income for the year \$3917.88. These figures are necessarily approximations, but they indicate that the entire income will be needed to publish Cereal Chemistry for the rest of the year on the basis followed for the first portion. The number of pages printed determines in large measure the cost of the journal, and

the size of the last issue of the year can be regulated in accordance with the balance credited to Cereal Chemistry at that time.

The managing editor reported in 1927 that there had been a steady increase in the number of pages of scientific material published per volume. This steady growth was maintained in Volume IV. The average number of pages per issue for each volume is given below. The number of pages indicated for Volume V is based on the first three issues and the estimate of the fourth.

Volume	I	1924	60 pages
"	II	1925	68 "
"	III	1926	72 "
"	IV	1927	84 "
"	V	1928	80 " (estimated)

While there has been an increase of 50 cents per member in the amount apportioned to Cereal Chemistry, the loss in members this year was barely equalled by the number of new members, with the result that the added income of Cereal Chemistry from this source is only $155. This amount is available for expansion of the journal, but will not permit a significant increase in its size. If all the increased income from dues were expended in enlarging the journal, the addition would be only 5 pages per issue.

The income from active and associate members' dues, while now 50 per cent of the dues collected, is alone entirely inadequate for publishing the journal in its present size. Only 25 per cent of the expense of publishing Cereal Chemistry can be paid by the revenue derived from dues of active and associate members.

The number of subscribers shows an increase in 1928. Nearly 700 copies of each issue are mailed. There are now 646 paid subscriptions (including members), compared to 589 a year ago.

Income from advertising, estimated from the first three issues of Volume V, will be about 20% greater than for Volume IV, 1927. Patronize your advertisers. They help support the journal.

Moved and seconded that all these reports be accepted. Carried.

Reports from the chairmen of the various local sections

Report of resolutions committee, by G. A. Alexander, chairman

Report of Resolutions Committee

WHEREAS, during the last year the milling industry lost, through death, an outstanding chemist, Harry Snyder, who was regarded as one of the foremost American authorities in the field of cereal chemistry, and a leader in the fight against the food faddists who malign white bread, and

WHEREAS, his kindly disposition, his simplicity of manner, and the spirit of helpfulness which guided his contact with associates will make the loss more deeply felt,

Be it resolved, that the sincere sympathy of the members of the American Association of Cereal Chemists be extended to his family and friends.

WHEREAS, the great success of this, the 14th annual convention of the American Association of Cereal Chemists, being held June 4 to 8 in the Nicollet Hotel, Minneapolis, is due to the hard work of our officers, L. R. Olsen, president; C. E. Mangels, vice-president; and R. K. Durham, secretary-treasurer; to the program committee; and particularly to the committee on local arrangements headed by M. A. Gray

Be it resolved that we express the thanks of the association to L. R. Olsen, C. E. Mangels, R. K. Durham, C. H. Bailey, C. O. Swanson, E. Tibbling, P. Logue, M. J. Blish, M. A. Gray and his assistants.

Be it resolved, that we likewise express our appreciation to donors to the convention fund and others who aided in our entertainment; to the to the University of Minnesota for its hospitality, and to the Nicollet Hotel for courtesy and efficient service.

Be it further resolved, that the association thank D. A. Coleman for the hard work which resulted in the publication of our first complete book of methods.

Be it resolved, that we extend cordial greetings to the Association of Operative Millers meeting with us in joint convention; and that we hope the bonds of mutual interest and respect which are now being renewed will lead to still greater things in the next year.

Be it further resolved, that the recognition of our work by the Millers' National Federation, as conveyed by H. L. Beecher, chairman of the board, is greatly valued and appreciated; and that we endeavor to co-operate fully with the federation, particularly in its campaign to educate the public to the superiority of white bread.

Be it resolved, that we accept the invitation of President Henry Stude of the American Bakers Association, to work closely with them in the solution of technical problems pertaining to flour and bread.

Be it further resolved, that we extend greetings to the American Society of Bakery Engineers and to the Association of Official Agricultural Chemists; and that it is our desire to co-operate with them fully in all of our mutual interests.

Be it resolved, that our secretary be instructed to spread these resolutions upon the minutes of this convention and to forward copies of the resolutions to those mentioned therein.

G. L. Alexander, Chairman
W. A. Richards
H. F. Vaupel
Resolutions Committee

Moved and seconded that this report be accepted and that we rise in memory of the late Professor Harry Snyder. Carried.

Election of officers

The following officers were elected:

President, C. E. Mangels
Vice-president, M. A. Gray
Secretary-treasurer, M. D. Mize
Editor-in-Chief, C. H. Bailey
Managing editor, R. C. Sherwood

Invitations for the 1929 convention were received from Detroit and Kansas City. A ballot was taken for the purpose of advising the executive committee of the choice of the members present. The votes cast were as follows: Detroit 49, Kansas City 36.

Adjourned to convention room of the Association of Operative Millers for joint meeting

Address by H. L. Beecher, chairman of board, Millers' National Federation

Address by Major S. Howe, President of Association of Operative Millers

Address by Leslie R. Olsen

Meeting adjourned, 12:30 p. m.

Thursday, June 7

Joint meeting with the Midwest Regional Meeting, American Chemical Society, in the auditorium of the Chemistry Building, University of Minnesota, Minneapolis, called to order at 10:00 a. m. by Dr. S. C. Lind, director of laboratories, School of Chemistry

Address by Dr. S. C. Lind

Address by C. B. Morison on Life of Dr. T. B. Osborne

Presentation of Thomas Burr Osborne medal, conferred by American Association of Cereal Chemists to Dr. T. B. Osborne by former president L. R. Olsen

Response and acceptance by Dr. Osborne read in his absence by C. L Alsberg

Paper—"Research and Profits," by C. S. Miner

Paper—"Treatment of Boiler Water and Failure of Boiler Plates," by S. W. Parr, president, American Chemical Society

Paper—"Application of X-rays," by F. L. Clark, University of Illinois

Meeting adjourned at 1:00 p. m. for luncheon with Midwest Regional Section

Dedication of new Biochemistry Building, University Farm, at 2:30 p. m.

Address by F. B. Snyder, president, Board of Regents, University of Minnesota

Address by W. C. Coffey, dean, Department of Agriculture, University of Minnesota.

Address by S. W. Parr, president, American Chemical Society.

Greetings from American Association of Cereal Chemists by former president, L. R. Olsen

Greetings from National Research Council, by F. C. Whitmore

Dedicatory Address—"Science and Life," by R. W. Thatcher, president, Massachusetts Agricultural College

Friday, June 8

Meeting called to order at 8:45 a. m. by president C. E. Mangels

Greetings and best wishes were received from Ralph Herman.

Report of auditing committee, by A. R. Sasse, chairman, that the books and accounts of the secretary-treasurer had been examined and found to be complete and correct

Moved by Newell that this report be accepted. Seconded, carried.

Moved by C. B. Morison that the recommendation of the executive committee that Dr. T. B. Osborne be made an honorary member of the association. Seconded, carried unanimously.

Paper—"The Effect of Stage of Maturity upon Composition and Quality of Marquis Wheat," by C. E. Mangels and T. E. Stoa

Paper—"Some Oxidizing Effects of Flour Bleaching," by E. B. Working

Paper—"The Correlation of the Ash Content of Wheat and Flour," by R. C. Sherwood and C. H. Bailey

Paper—"Some Applications of Spectrophotometric Methods to Baking Problems," by Eva L. Stephens, Alice M. Child, and C. H. Bailey

Paper—"Some Aspects of the Effect of Heat Upon Flour," by D. W. Kent-Jones

Paper—"Effect of Variation in the Method of Manufacture on the Baking Quality of Dry Skimmilk," by Emily Grewe

Moved by Kress that a brass strip with history be placed on gavel received from M. F. Dillon. Seconded, carried.

The new constitution, as proposed by the executive committee, was taken up article by article and, with a few minor changes, was adopted as follows:

THE CONSTITUTION OF THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS

Article I
Name

The name of this organization shall be THE AMERICAN ASSOCIATION OF CEREAL CHEMISTS.

Article II
Purposes of the Association

The purposes of this Association are (1) the encouragement and advancement of scientific and technical research in cereals and their products, particularly in milling and baking, but including also other industries in which cereals and their products are utilized, (2) the study of analytical methods used in cereal chemistry and the development and adoption of uniform (or standard) methods of examination and analysis, (3) the promotion of the spirit of scientific co-operation among all workers in the field of

cereal knowledge, (4) the maintenance of high professional standards in the association as conditions of membership and (5) to encourage a more general recognition of the chemist and biologist as essential factors in the development of the cereal industries. In accordance with these purposes this association shall conduct a journal in which contributions to the scientific knowledge of cereals, their products and technical application shall be published for the encouragement and advancement of the science. It shall hold meetings for the discussion of cereal knowledge and the promotion of research and technical co-operation among its members.

Article III
Membership

Section 1. The membership of this Association shall be divided into three classes (1) active, (2) honorary and (3) corporation.

Section 2. The active membership of this Association shall be restricted to—

(a) those persons having at least two years of chemical training in a college or university which has four years of high school work as a requirement for admission.

(b) those persons presenting evidence that they have the equivalent of (a) in training or experience, a part of which must consist of at least three years practical experience.

Section 3. Application for active membership shall be made in writing to the Secretary-Treasurer of the Association, and the applicant must be recommended by at least one active member of the Association.

Section 4. Applications for active membership when qualifications of applicant fully meet requirement of Section 2 (a) will be passed upon and approved by the Secretary-Treasurer, but in all other cases the Secretary-Treasurer will refer the application to the Executive Committee of the Association, their decision to be final.

Section 5. Honorary members may be elected by a three-fourths majority vote of the active members present at any general meeting, the candidate to be first proposed by one or more active members to the Executive Committee, who in turn shall report on the qualifications of the candidate to the general meeting.

Section 6. Corporations that are interested in or concerned with the use of cereals or cereal products may become corporation members upon application to the Secretary-Treasurer.

Article IV
Officers

Section 1. The elective officers of this Association shall be President, Vice-President, Secretary-Treasurer, Editor-in-Chief of Cereal Chemistry, and Managing Editor.

Section 2. Active members only shall be eligible to hold elective offices of the Association.

Section 3. Election of officers

(a) The President at each general meeting, shall appoint a Nominating Committee, which committee shall present at least one name for each of the five elective offices of the Association.

(b) Active members shall have the privilege of presenting additional nominations from the floor before ballot is taken.

(c) Election shall be by ballot and in order to be declared elected, a nominee must secure a majority of all votes cast.

(d) In case an elective office, except President, is vacated during term of incumbent, the President with advice and consent of the Executive Committee shall make appointment for the unexpired term of office. In case the office of President is vacated during term of incumbent, the Vice-President shall succeed and serve as President for the remainder of the term.

Section 4. Duties of Officers

(a) The President shall preside at all meetings and be the executive head of the Association. He shall appoint the necessary committees for conducting the business of the Association.

(b) The Vice-President shall preside at meetings in the absence of the President, and assist him in the duties of his office. He shall also act as Chairman of the Executive Committee. Bills of the Association shall not be paid except with the approval of the Vice-President, and all checks issued shall be countersigned by the Vice-President.

(c) The Secretary-Treasurer shall keep a record of the minutes of general meetings. He shall collect all fees and moneys due the Association, and pay all bills by check, and shall record all such receipts and expenditures. Bills shall not be paid except with the approval of the Vice-President and all checks issued shall be countersigned by the Vice-President.

(d) The Editor-in-Chief of Cereal Chemistry shall, with the consent of the President, appoint the Associate and Assistant Editors as may be necessary, and the same with the Editor-in-Chief shall constitute the Editorial Staff of Cereal Chemistry. It shall be the duty of Editorial Staff to select and prepare material for publication in the official organ of the Association.

(e) The Managing Editor shall make arrangements for the publication of Cereal Chemistry. He shall handle all business matters, including advertising, connected with the publication of the official organ of the Association.

Section 5. Executive Committee

(a) The President and the Chairman of the Executive Committee (Vice-President) shall jointly select three active members of the Association to act with them as an Executive Committee, two of whom shall be past Presidents of the Association.

(b) The President of the Association shall have privilege of voting in meetings of the Executive Committee.

(c) The Executive Committee shall co-operate with the President in carrying on the business of the Association between meetings. The Executive Committee shall have power to control the policy of the Association, between meetings, including finances.

Section 6. Auditing Committee

The President shall appoint three active members at each general meeting to act as an Auditing Committee. It shall be the duty of this committee to examine the books of the Secretary-Treasurer and report their findings to the Association. This committee, with the approval of the Executive Committee, may employ a certified accountant to audit these books.

Section 7. Additional Committees.

The President shall have power to appoint such additional committees as may be found necessary for the proper conduct of the business of the Association.

Article V

Dues and Fees

Section 1. Application fees

(a) The application fee for active membership shall be ten dollars, which shall include the first year's dues. The fee must accompany the application and will be returned in case application is rejected.

(b) The application fee is limited to active members.

Section 2. Dues—active members

(a) The dues of active members of this association shall be seven dollars per annum from January first to December thirty-first.

(b) Three dollars and fifty cents of the annual dues of active members shall constitute a subscription to Cereal Chemistry, and shall be set aside as such.

(c) Dues of active members are payable in advance, the membership card constituting a receipt for same.

Section 3. Honorary Members

Honorary members shall be exempt from all dues and fees.

Section 4. Corporation members

The dues of corporation members shall be ten dollars per annum, from January first to December thirty-first. Said dues are payable in advance, and shall be allotted to the publication fund.

Section 5 Delinquent members

(a) Annual dues are payable in advance to Secretary-Treasurer, and if not paid by March first of the current year, delinquents shall be dropped from membership, and their names removed from the mailing list of the Association.

Section 6. Assessments

Assessments not to exceed one year's dues may be levied when the current expense of the Association makes this necessary. The Secretary-Treasurer may recommend the levy of such assessment, which must be approved by the Executive Committee.

Article VI

Meetings, Elections and Privileges

Section 1. General meetings or conventions

General meetings or conventions shall be held annually, at such time and place as may be determined by the Executive Committee.

Section 2. Quorum

In all general meetings, an attendance of one-half of the active members of the Association registered at the meeting or convention shall constitute a quorum to transact business.

Section 3. Term of office

Officers of the Association shall be elected to serve for a term of one year or until their successors are installed.

Section 4. Voting privilege

Only active members of the Association shall be entitled to vote in meetings and in elections of officers of the Association.

Section 5. Privileges of Honorary and Corporation Members

(a) Honorary members and representatives of corporation members shall have the privilege of attending all general meetings and in addition the privilege of the floor, but shall have no vote.

(b) Honorary and Corporation members shall be entitled to receive the regular publications of the Association.

Article VII

Local Sections

Section 1. Local organizations or clubs of cereal chemists may upon application to the President and Executive Committee of the Association, be granted charters as local sections of the American Association of Cereal Chemists subject to the following provisions:

(a) All of the officers and at least three-fourths of the members of such organization shall be active members of the American Association of Cereal Chemists.

(b) The elective officers of sections shall be Chairman, Vice-Chairman, Secretary and Treasurer.

(c) Local sections shall have power to levy dues and assessments upon their members.

Section 2. In case of any dispute regarding territorial jurisdiction between sections, the matter shall be referred to the Executive Committee of the American Association of Cereal Chemists, their decision to be final.

Section 3. The President and Executive Committee of the American Association of Cereal Chemists may withdraw charters issued for failure to comply with constitutional provisions or other just cause. Such action shall not be taken until after full opportunity for a hearing shall have been afforded.

Article VIII
Amendments

Section 1. Amendments to this Constitution may be made at any general meeting. A two-thirds majority of the members present shall be necessary to carry.

Section 2. Amendments to this constitution shall state the Article and Section amended, and shall be submitted in writing to the Secretary-Treasurer and in turn be submitted to the members by mail or through Cereal Chemistry at least three months prior to meeting at which vote is taken.

Moved and seconded that this constitution be accepted. Carried.

Moved by Gray that all associate members of the association be made active members. Seconded, carried.

Meeting adjourned at 12:04 p. m. for luncheon in honor of the new officers.

Meeting called to order by President Mangels at 2:30 p. m.

Paper—"Some Fundamental Considerations of Flour Color," by C. G. Ferrari

Moved by R. J. Clark with the approval of the executive committee that the association show its appreciation of the efforts and work of the retiring secretary-treasurer R. K. Durham by voting $100 to him. Seconded, carried.

Paper—"Color of Flour," by F. Visser't Hooft and F. J. G. deLeeuw.

Discussion of this paper, followed by lengthy remarks by Kent-Jones

Paper—"Flour That Talks," by C. H. Bailey

H. D. Liggett extended to the association an invitation to hold another annual convention in Denver at any future date desired.

Appointment of committees by President Mangels:

Executive committee: M. A. Gray, chairman, R. J. Clark, L. R. Olsen, G. L. Alexander

Baking committee: C. G. Harrel, chairman, R. C. Sherwood, A. A. Towner, W. L. Heald, R. J. Clark, Emily Grewe, C. B. Morison, L. D. Whiting, M. J. Blish.

Committee on methods of analysis: M. J. Blish, chairman, L. H. Bailey F. A. Collatz, A. E. Treloar

Committee on employment: C. B. Morison, chairman, M. D. Mize

Osborne Medal committee: R. A. Gortner, chairman, C. L. Alsberg, A. W. Alcock, R. W. Stark

Publicity committee: L. D. Whiting, chairman, R. J. Clark, C. O. Swanson, John Micka, Paul Logue

Membership committee: A. A. Jones, chairman, Bert D. Ingels, L. E. Leatherock, C. B. Kress, W. A. Richards, Rolfe L. Frye, A. W. Alcock, C. T. Newell

Question committee: A. R. Sasse, chairman, H. F. Vaupel, W. C Meyer, Julius Hendel

Committee on flour specifications: F. A. Collatz, chairman, C. H. Bailey, L. R. Olsen, J. T. Flohil

Historian committee: R. W. Mitchell, chairman.

Committee on Book of Methods: D. A. Coleman, chairman, R. K. Durham, M. D. Mize

Committee on soft wheat flour investigations: Mary M. Brooke, chairman, G. L. Alexander, V. E. Fisher, J. M. Gillet, A. W. Meyer, A. A. Schaal, W. H. Strowd

Committee on allied associations: L. R. Olsen, chairman, H. E. Weaver

Moved by F. A. Collatz that convention adjourn. Seconded, carried.

REGISTRATION AT CONVENTION, MINNEAPOLIS, MINN. JUNE 4-8, 1928

H. Adler, Victor Chemical Works, Chicago, Ill.
Thomas R. Aitken, Board of Grain Commission, Winnipeg, Canada
A. W. Alcock, Western Canada Flour Mills, Winnipeg, Canada
George L. Alexander, Commercial Milling Co., Detroit, Mich.
C. A. Armstrong, Igleheart Bros. Inc. Evansville, Ind.
Henry A. Baehr, Topeka Flour Mills Co., Topeka, Kans.
C. H. Bailey, University of Minnesota, St. Paul, Minn.
L. H. Bailey, Bureau of Chemistry and Soils, Washington, D. C.
R. A. Barackman, Victor Chemical Works, Chicago, Ill.
W. L. Bergman, Industrial Appliance Co., Chicago, Ill.
H. M. Blinn, Doughnut Machine Corp., Baltimore, Md.
M. J. Blish, Agricultural College of Nebraska, Lincoln, Neb.
C. H. Briggs, Howard Laboratory, Minneapolis, Minn.
John P. Broderick, "The Northwestern Miller," Minneapolis, Minn.
C. L. Brooke, State Testing Mill, Minneapolis Minn.
Mary Minton Brooke, Purity Bakeries Corp., Chicago Ill.
Pearl Brown, Perfection Biscuit Co., Ft. Wayne, Ind.
H. T. Buchanan, State Protein Laboratory, Duluth, Minn.
Harris M. Butler, Willis Norton, Topeka, Kans.
Theodore E. Carl, The Fleischmann Co., New York City
Troy W. Carney, Brand-Dunwoody Mlg. Co., Joplin, Mo.
H. N. Clark, Blair Milling Co., Atchison, Kans.
Rowland J. Clark, Schulze Baking Co., Kansas City, Mo.
D. A. Coleman, Department of Agriculture, Washington, D. C.
F. A. Collatz, Washburn Crosby Co., Minneapolis, Minn.
A. P. Craik, Duluth-Superior Mlg. Co., Superior, Wis.
Paul H. Crane, International Milling Co., Minneapolis, Minn.
N. T. Cunningham, Ralston Purina, St. Louis, Mo.
A. E. Curtis, Midland Milling Co., Kansas City, Mo.
G. A. Davis, Pillsbury Flour Mills, Atchison, Kans.
J. A. Dunn, Wallace & Tiernan, Minneapolis, Minn.
F. L. Dunlap, Industrial Appliance Co., Chicago, Ill.
R. K. Durham, Rodney Milling Co., Kansas City, Mo.
Frank W. Emmons, Minneapolis, Minn.
Clarence Estes, Provident Chem. Works, St. Louis, Mo.
B. H. Fair, Noblesville Milling Co., Noblesville, Ind.
Charles G. Ferrari, University of Minnesota, Minneapolis, Minn.
C. C. Fifield, University of Minnesota, Minneapolis, Minn.
V. E. Fisher, Standard Tifton Co., Alton, Ill.
Augustus H. Fiske, Rumford Chemical Works, Providence, R. I.
Henry J. Fleming, Nebraska Con. Mills, Omaha, Neb.
T. G. Fletcher, Wichita Mill & Elevator Co. Wichita Falls, Tex.
Henry Flick, Washburn Crosby Co., Louisville, Kentucky
John T. Flohil, Pillsbury Flour Mills, Minneapolis, Minn.
Fratzke, Western Flour Mills, Davenport, Iowa
Rolfe L. Frye, Valier-Spies, St. Louis, Mo.
L. H. Goebel, Wallace & Tiernan Co., Newark, N. J.
C. B. Gustafson, University Farm, St. Paul, Minn.
W. E. Glasgow, Cargill Elevator Co., Minneapolis, Minn.
R. A. Gortner, University of Minnesota, St. Paul, Minn.
M. A. Gray, Pillsbury Flour Mills, Minneapolis, Minn.
Gertrude B. Gray, Purity Bakeries Corp., Chicago, Ill.
N. L. Gregory, Maple Leaf Milling Co., Port Colborne, Ont.
Emily, Grewe, Bureau Dairy Industry, Washington, D. C.
Ruth Hallman, St. Lawrence Flour Mills, Montreal, Canada.

Geo. E. Hammer, International Mlg. Co., Minneapolis, Minn.
Rae H. Harris, St. Paul, Minn.
Raymond Hertwig, Hecker H-O, Inc., Buffalo, N. Y.
Henry W. Hahn, Gilster Milling Co., Steeleville, Ill.
W. L. Heald, Larabee Flour Mills, Kansas City, Mo.
C. G. Harrel, Bakeries Service Corp., New York City
A. E. Hardy, Charleston Milling & Pro. Co., Charleston, W. Va.
Julius Hendel, Cargill Elevator Co., Minneapolis, Minn.
Geo. L. Howard, Moore-Lowry Flour Mills, Kansas City, Mo.
Rose Holub, International Milling Co., Minneapolis, Minn.
Bert D. Ingels, Wallace & Tiernan Co., Minneapolis, Minn.
Chas. W. Ingman, State Grain Inspection, Minneapolis, Minn.
A. A. Jones, Hoyland Flour Mills, Kansas City, Mo.
L. E. Jackson, Victor Chemical Works, Chicago, Ill.
Joseph H. Julicher, Pillsbury Flour Mills, Buffalo, N. Y.
H. H. Johnson, Gooch Milling & Elevator Co., Lincoln, Neb.
W. H. Jones, St. Louis Novadel Co., St. Louis, Mo.
D. W. Kent-Jones, Messrs. Woodlands, Ltd., Dover, England
C. B. Kress, Sperry Flour Co., San Francisco, Calif.
F. L. La Motte, La Motte Chemical Prod. Co., Baltimore, Md.
Fred Leonard, New Ulm, Minn.
Fred J. Lumsden, King Midas Mill Co., Minneapolis, Minn.
H. D. Liggett, Jr., Colorado Mill & Elev. Co., Denver, Colo.
Paul Larson, Sioux City Grain Co., Sioux City, Iowa
S. J. Lawellin, Wallace & Tiernan Co., New Ulm, Minn.
F. J. G. de Leeuw, Novadel Process Corp., Buffalo, N. Y.
Paul Logue, Provident Chemical Works, St. Louis, Mo.
Omer Luff, Big Diamond Mills, Minneapolis, Minn.
C. E. Mangels, North Dakota Experiment Station, Fargo, No. Dak.
Jan Micka, Trent Institute, Ontario, Canada
Ed. M. Morgan, Phosphate Products Corp., Richmond, Va.
R. Wallace Mitchell, American Baker Materials Co., Menomonie, Wis.
Claude L. Moore, Washburn Crosby Co., Buffalo, N. Y.
C. H. Mac Intosh, C. J. Paterson Corp., Kansas City, Mo.
Nell McNeil, Southwestern Laboratories, Kansas City, Mo.
C. Brewster Morison, Am. Inst. of Baking, Chicago, Ill.
M. D. Mize, Omaha Grain Exchange, Omaha, Neb.
A. W. Meyer, W. E. Long, Chicago, Ill.
G. Moen, Washburn Crosby Co., Minneapolis, Minn.
J. H. Monson, Robin Hood Mills, Ltd., Moose Jaw, Sask., Canada
W. C. Meyer, Ismert-Hincke Milling Co., Kansas City, Mo.
C. T. Newell, Burrus M. & E., Fort Worth, Texas
J. Wm. Nelson, W. J. Jennison Co., Appleton, Minn.
E. F. Olmstead, Gt. West Mill & Elev. Co., Amarillo, Texas
Leslie R. Olsen, International Milling Co., Minneapolis, Minn.
Aksel G. Olsen, Postum Cereal Co., Battle Creek, Mich.
E. E. Palmer, Hubbard Milling Co., Mankato, Minn.
E. M. Paget, Rumford Chemical Works, Chicago, Ill.
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P. R. Pitts, Model Mill Co., Johnson City, Tenn.
E. C. Paulsel, International Milling Co., Minneapolis, Minn.
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Raymond Powers, Minneapolis, Minn.
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John A. Thill, Stokes Milling Co., Watertown, So. Dak.
W. M. Tinkham, Washburn Crosby Co., Minneapolis, Minn.
G. Van der Lee, Novadel Co., Deventer, Holland
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Gordon Whiteside, Cereal Division, Experimental Farm, Branch, Ont., Canada
H. E. Weaver, Kansas Flour Mills Corp., Kansas City, Mo.
A. D. Wilhoit, Wilhoit Lab., Minneapolis, Minn.
W. O. Whitcomb, Montana Grain Insp. Lab., Bozeman, Mont.
Floyd Woosley, Omaha Flour Mills, Omaha, Neb.
Lawrence Whiting, Ballard & Ballard Co., Louisville, Ky.
Victor de Wysocki, Shredded Wheat Co., Niagara Falls, N. Y.
E. Ziegler, K. S. A. C., Manhattan, Kan.
D. H. Ziel, Kansas Flour Mills, Alva, Okla.

Guests

Mrs. C. H. Bailey, St. Paul, Minn.
Harold Boyd, Cargill Elev. Co., Minneapolis, Minn.
D. L. Boyer, Provident Chemical Works, St. Louis, Mo.
Mrs. C. H. Briggs, Minneapolis, Minn.
W. E. Brownlee, Minneapolis, Minn.
Mrs. H. M. Butler, Topeka, Kans.
Mrs. Troy W. Carney, Joplin, Mo.
Mrs. R. J. Clark, Kansas City, Mo.
Mrs. F. A. Collatz, Minneapolis, Minn.
Frank N. Cyr, Washburn Crosby Co., Minneapolis, Minn.
Mr. F. H. Faber, Despatch Oven Co., Minneapolis, Minn.
Miss Kitty Fiske, Providence, R. I.
Mrs. A. H. Fiske, Providence, R. I.
Mrs. J. T. Flohil, Minneapolis, Minn.
J. S. Gaines, Despatch Oven Co., Minneapolis, Minn.
Mrs. W. E. Glasgow, Minneapolis, Minn.
Mrs. R. A. Gortner, St. Paul, Minn.
Mr. A. E. Grapp, Despatch Oven Co., Minneapolis, Minn.
Mr. H. L. Grapp, Despatch Oven Co., Minneapolis, Minn.
Mrs. H. L. Grapp, Minneapolis, Minn.
Mrs. M. A. Gray, Minneapolis, Minn.
Mrs. R. H. Harris, St. Paul, Minn.

C. A. Hoppert, Soft Wheat Millers Assn., Nashville, Tenn.
Otto Johnson, Tech. Bureau Biscuit and Cracker Mfrs. Assn., Minneapolis, Minn.
Miss Mary Innes, Minneapolis, Minn.
Mrs. Bert Ingels, Minneapolis, Minn.
Mrs. C. W. Ingman, Minneapolis, Minn.
Mrs. A. A. Jones, Kansas City, Mo.
C. J. Kittleson, Bliss Laboratory, Minneapolis, Minn.
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Mrs. L. R. Olsen, Minneapolis, Minn.
Mrs. A. G. Olsen, Battle Creek, Mich.
Mrs. E. E. Palmer, Mankato, Minn.
Mrs. L. H. Patten, Jr., Grand Forks, N. D.
Mrs. E. C. Paulsel, Minneapolis, Minn.
O. H. Raschke, Victor Chemical Works, Chicago, Ill.
Thomas C. Roberts, Washburn Crosby Co., Minneapolis, Minn.
Mrs. T. Sanford, New Ulm, Minn.
Mrs. A. R. Sasse, Kansas City, Mo.
Mrs. A. A. Schaal, Minneapolis, Minn.
Fernando Selvela, Spanish Embassy, Washington, D. C.
Mrs. R. C. Sherwood, St. Paul, Minn.
Takaki Shin-Ichi, The Naval Paymasters College, Tokyo, Japan
Mrs. V. Shiple, Toledo, Ohio.
Mrs. H. R. Swanson, Calgary, Canada
Miss Irene Swanson, Janesville, Minn.
Robert Lee Stewart, Christian Becker & Torsion Balance Co., Chicago, Ill.
Mrs. J. A. Thill, Watertown, So. Dak.
L. F. Thompson, Minneapolis, Minn.
Mrs. H. F. Vaupel, El Reno, Okla.
Mrs. M. R. Warren, Cedar Rapids, Iowa.
Mrs. Harry E. Weaver, Kansas City, Mo.
Mrs. W. O. Whitcomb, Bozeman, Mont.
Mrs. A. D. Wilhoit, Minneapolis, Minn.
Mrs. E. Ziegler, Manhattan, Kans.

NOTE ON THE MEASUREMENT OF VISCOSITY IN FLOUR SUSPENSIONS

By H. J. Denham, G. Watts, and G. W. Scott-Blair
Research Department, Henry Simon, Ltd., Manchester, England

(Received for publication May 10, 1928)

G. van der Lee (1928) in a recent paper criticises the discussion by the authors on the viscosity of flour suspensions on two grounds: (a) that it is not possible to measure the true viscosity with a MacMichael viscometer, and (b) "since in many cases a kind of elasticity not found in true liquids is observed," it is not possible to determine the viscosity in a strict sense.

As regards the first, it was, unfortunately, not stated in the first paper that all results discussed have been obtained with an Ostwald viscometer, which, as we have shown in a second paper (1927), gives consistent results on flour suspensions, even with capillaries of widely varying bore.

We agree that the MacMichael viscometer does not give consistent results on colloidal suspensions, and for that reason it has never been used in this laboratory. At the same time, the Sharp and Gortner equation appears to be applicable to the results obtained with the Ostwald viscometer, although we consider that our own modification of the formula gives more satisfactory results. The first question raised by Van der Lee, therefore, does not arise, and the secondary considerations arising from this question are completely invalidated.

As regards the question of plasticity in colloidal suspensions, one of the authors (G.W.S-B.) will shortly publish a paper in another journal giving more particularly the general theoretical treatment of these phenomena.

Literature Cited

Van der Lee, G.
1928 The viscosity of flour suspensions. Cereal Chem. **5**:10-13.
Denham, H. J., Scott-Blair, G. W., and Watts, G.
1927 Notes on the use of Ostwald viscometers for flour suspensions. Cereal Chem. **4**:206-220.

BOOK REVIEW

A Comprehensive Survey of Starch Chemistry. Vol. I. Compiled and edited by Robert P. Walton. The Chemical Catalog Co., Inc. New York. 240 + 360 pages.

This is another of the increasing list of scientific volumes written by a number of contributors, each a leader in his respective field. The book is divided into two parts: (I) a symposium, and (II) a bibliography, The roster of the score of chemists who contributed to the symposium on starch is international in character and includes about as many Europeans as Americans. Certain of the subjects covered include (1) thermal depolymerization, by Pictet; (2) methylation, by Irvine; (3) enzymic hydrolysis, by Ling; (4) bacterial degradation, by Pringsheim (these four phases are discussed in their relation to molecular constitution); (5) colloid-chemical properties, by Samec; (6) non-carbohydrate constituents, by Taylor; (7) X-ray spectography, by Katz; (8) chemical nature of certain amylases, by Sherman; (9) rôle of starch in bread-making, by Alsberg; (10) bread-staling, by Katz; (11) fermentation industries, by Fernbach; manufacture (12) of corn starch, by Moffet; (13) of potato starch, by Preuss; (14) of dextrins and gums, by Bloede; (15) of starch and flour adhesives, by Alexander; (16) starch viscosity and paper and textiles, by Nivling; (17) use of starch in textiles, by Farrow; (18) starch-converting enzymes used in the textile industry, by Gore, Turley, Wallerstein, and Takamine, and (19) early development of starch chemistry and manufacture, by Walton, who served as editor of the symposium. This part of the book covers 240 pages.

Part II, bibliography, occupies 360 pages. It is more than a bibliography, since brief abstracts follow each citation with cross references to other abstracts that have appeared in the various abstract journals. These abstracts are classified under two major groups: (I) Starches and dextrins, and (II) Amylases. Each of these groups is further subdivided under suitable topic headings.

The monograph constitutes a convenient source of facts concerning starch chemistry and starch technology. Each section is relatively brief and concise. Little space is devoted to chemical theory. Instead, the observed chemical and physical phenomena are recorded in logical order and processes of manufacture are described, particularly with reference to physical manipulation. In certain instances it appears, to the reviewer, that the processes are not presented in sufficient detail to inform the tyro, or to be of material value to the experienced technologist.

Katz's chapter on bread staling is probably the first comprehensive summary in English of his notable researches.

Alsberg's discussion of the rôle of starch in bread making is unique, and will prove of interest and value to flour mill and bakery chemists.

—C. H. Bailey.